Regulation of Multinational Banks: A Theoretical Inquiry*

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Abstract

This paper examines prudential regulation of a multinational bank by independent national authorities. Both the liability structure between home and foreign units and the division of regulatory tasks among national regulators are crucial to explain regulatory intervention under the distinct representation choices for foreign units (branch or subsidiary). Shared liability produces greater intervention than does legal separation. Cross-border deposit insurance yields less intervention than when regulators compensate local depositors only. We also derive implications on the bank' s and regulators' preference on foreign expansion and the different representation forms.

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1 Introduction

Multinational banking has expanded significantly as barriers to international capital flows have been progressively dismantled and entry to foreign markets has eased.[1] The rapid development of multinational banks (MNBs hereafter) represents a source of new concerns for regulators. An MNB, consisting of a home bank and a number of foreign-located banks, can easily take advantage of ill-harmonized national regulations. Furthermore, regulation of an MNB in one country may well affect the behavior of the bank and of regulators in other countries. This paper provides a simple framework for examining regulatory actions by independent national authorities in a multinational bank setting. We analyze national regulators' incentives to intervene in bank units, the extent to which these incentives differ with the type of foreign incorporation, and we derive implications for the decision of a bank to expand abroad (thus becoming an MNB) and the associated choice of representations.

We consider a setup where an MNB operates in two countries. The bank is legally incorporated in the 'home country' (with a home unit) and operates an additional unit in the 'foreign country.' Each unit collects deposits that invests locally in risky and illiquid projects. Bank regulators have two mandates: they (fully) insure depositors and exercise prudential intervention over the unit they are in charge of. In this respect, we first consider a setup in which regulators exercise their mandates with the aim of minimizing costs stemming from their deposit insurance function.[2] Regulators thus face the following trade-off: intervention always secures some assets, but leads to certain deposit insurance costs, on the contrary letting a unit to continue might lead to no costs for the regulator if the unit's investment pays out, but might result in a higher deposit insurance cost if the unit does not succeed.

We ask how this trade-off is affected by the liability structure between the home and foreign units, as well as by the division of regulatory tasks between national regulators. In this respect, the representation (or incorporation) form chosen for the foreign units plays a critical role. Here, we will consider two types of representation, namely branch and subsidiary.[3]

The bank constitutes a single legal entity when its business abroad is conducted *via* branches, so that the home unit shares joint liability with the foreign branch for its losses (and vice versa). Subsidiaries, on the other hand, are separately incorporated entities. The home unit is shielded

[1] Total assets held by the overseas units of US banks doubled from 1992 to 1996. In the United States, foreign banks accounted for almost 10 percent of deposits in 2000 (Buch and Golder, 2001) and, in 2001, for 20 percent of total bank assets and 26 percent of total business loans (Federal Reserve Board, 2002). In Central Europe bank assets controlled by foreign banks rose from 8 percent in 1994 to 59 percent in 1999. Almost 50 percent of total bank assets in some Latin American countries are controlled by foreign banks (IMF, 2000). For more details, see Calzolari and Loranth (2003).

[2] The FDIC in the United States was given this type of objective function by the FDICI Act of 1992, which mandated a least-cost resolution method and prompt resolution approach. The FSA in the UK shares a similar mission. In the academic literature, the regulators' role in insuring deposits has been emphasized by Mailath and Mester (1994) and Repullo (2000, 2001), among others. In the extensions we will also consider welfare-maximizing regulators.

[3] Other forms (e.g. correspondent banks, representative offices and agencies) do not allow the full range of banking activities and are thus much less pertinent to our analysis.

from losses of foreign subsidiaries; but, as a subsidiary is itself an asset of the home bank, it shares liability with the home bank for losses in the home country. The higher independence of subsidiaries relative to branches is also reflected in the allocation of supervisory tasks. In line with current EU regulation, we assume that supervision is centralized by the home country's regulator (in short, the home regulator) in branch-represented MNBs, and the home regulator also provides deposit insurance for all depositors independently of their location. In subsidiary MNBs, the home and foreign regulators have independent power over the locally incorporated unit, and depositors call upon the local deposit insurance scheme in the event of bankruptcy.[4]

We show that there is a material difference in the likelihood of regulatory intervention between branch and subsidiary MNBs, and the difference can be attributed to two effects: (i) the extent to which the regulator of a given unit can draw upon the residual assets of the other unit if the unit's assets falls short of liabilities; and (ii) the regulator's payout responsibility for depositors located in the other country. Where it occurs, shared liability among the MNB's units provides more incentives for regulatory intervention than when units are legally separate, since a regulator can reduce the cost of intervention in one unit by taking assets of the other, once its depositors are paid out. This effect, which we dub the *equity stake effect*, applies to the (single) regulator of a branch MNB, and also to the behavior of the home regulator in a subsidiary MNB. On the other hand, responsibility for insuring depositors in both countries, as with branch representation, makes a regulator internalize the full costs of its decisions. In particular, the regulator takes into consideration that intervention in a given unit leaves no assets to support the other unit in case of need: this *internalization effect* reduces the regulator's incentives of intervention in a given unit.

These two effects are the main drivers of a number of implications concerning regulators' behavior. First, when the MNB takes the subsidiary representation, the regulator of the home unit is 'tougher' than the foreign one (i.e., either their decisions coincide or the former intervenes whilst the latter does not). Joint liability makes the home regulator a residual claimant on foreign assets, and the value of this claim is greater upon intervention since it makes the claim certain, while with no action the claim is only valuable if the home unit fails. Furthermore, as the value of this claim on foreign residual assets is positive only if the foreign unit is let to continue, the home regulator is more likely to intervene when the foreign unit is kept open. On the contrary, there is no such effect for the foreign regulator, because in subsidiary representation the home unit is shielded from the foreign unit's losses.

Second, the home unit falls under 'softer regulation' with branch than with subsidiary representation (i.e., either intervention takes place in both representations or it does so with subsidiary but not with branch MNBs). Unlike the regulator of a branch MNB, the home regulator in a subsidiary MNB is not responsible for foreign depositors, in which case there is no internalization of the impact of the decision on foreign regulation costs. Furthermore, a foreign subsidiary faces softer regulation than does a foreign branch if the home unit's prospects are good (i.e., its prob-

[4] This description closely follows current EU regulations (see Dermine, 2002). In the United States, branches of foreign banks are treated as separate entities and supervised by US authorities, similarly to subsidiaries under the EU rules (for more details see Houpt, 1999 and Bain et al., 2003). Albeit the terminology is different between the States and the EU, what matters for our analysis is the liability structure and the allocation of regulatory powers.

ability of succeeding is high), but faces tougher regulation if those prospects are bad. Indeed, on the one hand, because of the equity stake effect, a foreign branch faces tougher regulation than does a subsidiary. On the other hand, because of the internalization effect, a single regulator caring for deposit insurance costs in both countries tends to be softer on any of the units, i.e., also on the foreign unit. The balance of the two effects depends on the prospects of the home unit. When these are poor, intervention is likely in the home unit and only the second effect is relevant. When home prospects are good, the first effect prevails, since it is more likely that home assets can be used to reduce foreign costs than residual assets will be needed to reduce home losses.

The two effects identified here also allow a comparison of regulatory intervention in the home unit of a MNB with that in a domestic bank operating in a single country. In particular, we find that the latter faces softer regulation than the home unit of a subsidiary MNB. This is an immediate consequence of the shared liability of the MNB units that allows the regulator to lower its cost in the home unit by residual assets remaining in the foreign unit. The comparison with the home unit of a branch MNB is more complex. If intervention is likely in the foreign unit, because of the internalization effect the regulator of a branch MNB is softer on the home unit than would be with a domestic bank. When, instead, intervention is unlikely in the foreign unit, the equity stake effect dominates, and, as a consequence, the home unit of a branch MNB faces a tougher regulation than would a domestic bank.

The different regulatory regimes a bank faces are often said to be relevant to the choice of foreign representation (even if it is certainly not the sole driver of the decision: see Houpt, 1999; Calzolari and Loranth, 2003; Focarelli and Pozzolo, 2006). The trade-off between remaining domestic and expanding abroad, either *via* branches or subsidiaries, can be summarized as follows: On the one hand, a foreign unit is a potential source of additional profits. On the other hand, a foreign unit can drain profit from the home unit as a consequence of joint liability for losses. By comparing the likelihood of intervention under the branch and subsidiary representations, we can examine a bank's choice of whether to expand abroad and the optimal representation form to adopt. We find that when the home unit is not very likely to succeed, foreign expansion with a branch representation is preferred, as it induces more lenient regulation over all units. When instead the home prospects are very good, the bank prefers to expand abroad via subsidiary, since home profit in a subsidiary MNB is protected by limited liability of the home unit over the subsidiary's potential losses. Finally, for intermediate probability of success, the bank prefers not to expand and remains a domestic bank. We then contrast the bank's optimal choice with (home and foreign) regulators' preferences over foreign expansion and representation, thus showing the possibility of conflicting interests.

In addition to costs, regulators may also be concerned with bank profits as a consequence of successful lobbying or because profits affect the financial stability of the local banking sector. We show, in this case, that the strategic interaction between two independent national regulators of a subsidiary MNB gives rise to potentially ambiguous regulatory actions (where in fact the unique equilibrium is in mixed strategies). Nevertheless, as one may expect, we find that profit concerns shift regulatory decisions towards softer behavior. We also show that the bank either prefers to remain domestic or to expand abroad with a subsidiary.

The present work is part of a growing literature on the regulation of MNBs. Calzolari and Loranth (2003) provide a general introduction to the issue.[5] Holthausen and Rønde (2005), Acharya (2003), Dell'Ariccia and Marquez (2006), and Dalen and Olsen (2006) address the problem of divergent interests and lack of coordination between national regulators. Our new insight is that divergence of interests (and decisions) between regulators might result from the type of representation chosen by the MNB. Unlike earlier work, we examine in detail the interplay between the MNB's liability structure and the allocation of supervisory functions and their effect on prudential supervision and representation choice. The question of whether the form of MNB representation affects regulation has also been raised by Harr and Rønde (2006) and by Loranth and Morrison (2007).[6] Those papers focus on optimal capital requirements; however, our contribution focuses on regulators' incentives to take disciplinary actions. In an early contribution, Repullo (2001) addresses the problem of the domestic regulator's limited information (for supervision and deposit insurance) and offers some conclusions concerning the incentives that lead to cross-border takeovers. Our paper differs in studying the effects on regulation of the form of MNB representation and in endogenizing the MNB's choice of representation.

Our modelling choice of bank supervision is most closely aligned with that of Mailath and Mester (1994), who also consider a positive theory of regulatory intervention. In their paper, a (domestic) bank invests sequentially into two projects, and regulatory intervention prevents the financing of a second project. The (single) regulator anticipates future bank's asset choice (over safe or risky assets) in case it is permitted to remain open and, understanding that the initial investment decision will affect the regulator's policy, the bank modifies its first period risk-taking behavior. Considering both a cost-minimizing and welfare-maximizing regulator, this paper shows some analogies with our analysis. In particular, the authors show that the regulator might be induced to leave open a bank with negative expected value, since the returns of the second project allow the regulator to reduce reimbursement costs of the first-period project. Thus, in their paper, too, regulatory decisions might be driven by the possibility of getting some equity out of the second project. However, the main driver for this effect is different in the two papers. In their paper, it is generated by a dynamic interaction between the bank and the regulator, and an essential ingredient is the commitment problem on the side of the regulator to punish the bank after having chosen a risky (negative net present value) project. This also explains why the issue still remains when the regulator maximizes welfare. In our paper, instead, the equity stake effect arises because of shared liability between two (geographically) separate units. This effect is present as long as units are separately supervised and even when regulators maximize welfare. However, the effect vanishes with a single regulator maximizing welfare in two countries. Finally, our analysis of an MNB with subsidiary representation brings in strategic interaction among independent national regulators, which is clearly absent from Mailath and Mester (1994).

The rest of the paper is organized as follows. Section 2 presents the base model. Section

[5] See also Calzolari (2001; 2004) for an analysis of regulation of multinational enterprises in the context of public utilities.

[6] In a different setting, Kahn and Winton (2005) also examine the effect of financial institutions' structure (subsidiary or unitary) on risk-taking and project selection.

3 analyzes regulators' incentives to intervene under the two representations. Section 4 discusses bank's and regulators' preferences over foreign expansion and representation. Section 5 extends the base model to regulators who are also concerned by the MNB's profit. Section 6 concludes. Proofs are in the Appendix.

2 A model of the regulation of multinational banks

Consider an MNB incorporated in country h (the home country) and with a unit in country f (the foreign country). The MNB raises fully insured deposits of amount 1 in each country and invests them locally. Deposits pay an interest rate that is normalized to zero. Each unit runs an illiquid and risky project that pays out either R (in case of success) or 0 (in case of failure) at the last stage of the game $t = 2$.

At $t = 1$ the probability of project i returning R is $p_i \in (0, 1)$, $i = f, h$, and, acting upon this knowledge, regulators decide whether or not to intervene in the unit for which they are responsible. We refer to this activity as *prudential regulation*. Intervention results in early liquidation of the project, yielding $L \in [0, 1)$; more generally it can be thought of as conservatorship, or ring-fencing, i.e., a move to protect the assets of a given unit or to limit the exposure of the MNB to certain categories of risk. Alternatively, the regulator may decide to take no action. In general, the decision of the regulator in country i will be indicated with $d^i \in \{I, O\}$ where $d^i = I$ stands for intervention and $d^i = O$ corresponds to the decision to keep unit i open.[7]

We assume that (i) at $t = 2$ a successful project returns more than the amount invested, i.e., $R > 1$, but (ii) the MNB's assets of a single project are insufficient to reimburse depositors in both countries i.e., $R < 2$. Furthermore, if one project is subject to intervention at $t = 1$ or fails at $t = 2$, the MNB's assets are insufficient to reimburse depositors in both countries, regardless of the other project's realization, i.e., $R + L < 2$. Unless explicitly and differently stated, this will be our benchmark case, but we will also complete our analysis by considering the case with $R + L \geq 2$.[8]

Regulators' objective. We assume that regulators minimize the (expected) deposit reimbursement costs that may arise as a consequence of intervention at $t = 1$ (named intervention costs) or failure at $t = 2$ (named failure costs). In Section 5, we also discuss prudential regulation under the assumption that regulators are concerned with national welfare and also care about the MNB's profits.

Foreign Representation. We examine two types of representation for the foreign unit: subsidiary and branch.[9]

A *subsidiary* is a separately incorporated entity in the foreign country that shares the liability

[7] The desirability of early intervention, so as to secure certain assets L instead of risking larger losses in case of failure, is consistent with the doctrine of "Prompt Corrective Action" adopted, for example, in the United States.

[8] For reasons of space, the proofs of all the Propositions for case $R + L \geq 2$ are in the Supplementary Material available on the authors' web pages.

[9] In the following we will indicate the foreign unit simply as "the subsidiary" or "the branch" depending on the representation form.

for the home bank's losses, but for whose losses the home bank is not liable. More precisely, in the case of home unit failure, all remaining residual assets in a solvent subsidiary – after foreign depositors are paid off – must be used against home liabilities. No such transfer from a solvent home unit to an insolvent subsidiary is required. With a subsidiary MNB, each national regulator performs prudential regulation over its local unit and insures local depositors. Regulators' decisions are assumed to be taken non-cooperatively.

A *branch* can be thought of as an extension of the "mother" bank, thus forming a single entity. In this case, insolvency occurs when the total assets of the MNB in both units fall short of total liabilities. The regulator in the home country performs prudential regulation and insures depositors in both countries. In an insolvency, local depositors are paid off first from local assets (if there are any), and the regulator collects the remaining assets to reduce the deposit insurance losses in the other country. This particular description is only for convenience because, as noted, the home regulator insures depositors in both countries. At $t = 1$ the regulator's decision is for intervention in one, both, or neither of the two units.[10]

In what follows, we refer to the regulator by location. Thus, the single regulator of a branch MNB and of the home unit of a subsidiary MNB is the *home regulator*. The regulator of the foreign unit in a subsidiary MNB is the *foreign regulator*. For any pair of regulatory decisions, the first letter will refer to unit h and the second to unit f, e.g., (I, O) means that the regulator in charge of unit h intervenes, and the one in charge of unit f does not.

Regulators and bank managers are risk-neutral and there is no discounting. We summarize our base model with the following timing of the moves:

Timing

- At $t = 0$: The bank decides whether to expand abroad and chooses a type of foreign representation; it collects deposits in countries in which it is active and invests them in risky projects.
- At $t = 1$: Regulators decide whether to intervene in the project of the unit under their respective jurisdiction.
- At $t = 2$: Payoffs are realized and depositors are repaid.

In what follows, we first analyze regulatory decisions at $t = 1$, assuming that an MNB is formed and is active in both countries. We subsequently discuss the $t = 0$ decision by a domestic bank (with a single unit) of whether to form a multinational bank and, if so, of what representation form to choose.

Finally, to save on notation and for concreteness, in what follows when we state that "*regulator i is tougher in case A than in case B*," we refer to a situation when either regulator i's $t = 1$

[10] Similarly, current EU regulations follow the principle of home country supervision. Hence, the competent authority supervising the bank is the country where the bank is initially licensed. Supervisory responsibilities cover the activities carried out in the form of branches throughout the EU or by cross-border supply of services. See the Second EU Banking Coordination Directive issued in 1989 and made effective on January 1, 1993.

decisions coincide in the two cases, or the optimal decision is $d^i = O$ in case B, and it is $d^i = I$ in case A (conversely when the regulator is instead *softer*). A consistent locution will also be used when comparing the home and the foreign regulators' decisions, so that, for example, "*Regulator i is tougher than regulator j*" means that either decisions coincide or they are $d^i = I$ and $d^j = O$.

3 Prudential regulation

In this section, we examine regulators' decisions whether to intervene in the unit(s) under their respective jurisdiction at $t = 1$.

It is useful to consider first the trade-off faced by a cost-minimizing regulator of a domestic bank with a single-unit (simply, domestic bank in what follows). Early intervention at $t = 1$ leads to a cost $-(1 - L)$, while taking no action might lead to zero costs if unit i yields returns R, but might result in a higher cost of -1 if it returns zero. The regulator, therefore, compares the liquidation value L that can be obtained from intervention with the unitary (reimbursement) cost saving that can be expected with probability p_i in the case of non-intervention. Hence, intervention is optimal if and only if $p_i < L$. This simple trade-off in a multinational bank can be affected by two additional considerations: (i) the joint liability of units over losses and (ii) a regulator's responsibility towards depositors in the other country.

3.1 Subsidiary MNBs

With a subsidiary, MNB regulation is decentralized, that is at $t = 1$ the home and the foreign regulators make decisions about the local unit simultaneously and non-cooperatively.

Consider first the decision of the foreign regulator. Because foreign depositors have priority over the subsidiary's assets and the home unit has limited liability for the foreign subsidiary's losses, the foreign regulator's decision is not affected by the prospects of the home unit nor by the home regulator's decision. It is thus no different from that of the cost-minimizing regulator of a domestic bank.

The situation for the home regulator is different. If the foreign unit is kept open at $t = 1$ and is successful at $t = 2$, the home regulator can use the residual assets from that unit to reduce home costs. Intervention in the foreign unit at $t = 1$, by contrast, leaves no foreign assets to transfer home. Hence, the home regulator would prefer the foreign regulator to be "lenient": an open foreign unit gives it a chance of leaving some residual assets that can be used to safeguard home deposits.

Furthermore, the value of those assets are higher to the home regulator when intervening in the home unit than when leaving it open. With intervention, the home regulator has a certain claim to the residual assets of the foreign unit, with an expected value of $p_f(R - 1)$; upon no intervention, those residual assets are only useful if the home project fails and therefore are worth $(1-p_h)p_f(R-1)$ in expectation. Thus, the ex-ante value of this claim is greater upon intervention than without. This in turn implies that the potential "equity" returns from the foreign unit make the home regulator tougher compared to a cost-minimizing regulator of a domestic bank with a single unit. We will refer to this as an *equity stake effect*. Formally, if the foreign unit is open, the home regulator intervenes if and only if $p_h < \delta_h$ where $\delta_h \equiv L/[1-p_f(R-1)] \geq L$. Instead, when the foreign unit is subject to intervention, the decision of the home regulator clearly coincides with that of the regulator of a domestic bank, and intervention is optimal if and only if $p_h < L$.[11]

Combining these effects, we can draw the following figure to describe the decisions that constitute the (unique) equilibrium of regulatory interaction for any pair of probabilities (p_h, p_f).

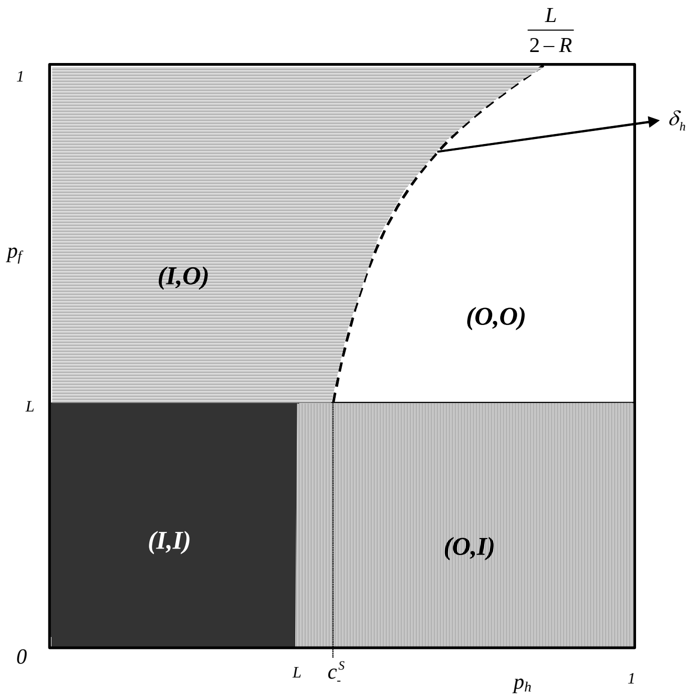

Figure 1: Regulators' decisions (d^h, d^f) with subsidiary-MNB.

Note that the foreign regulator's decision is clearly unaffected by p_h, as the regulator cannot benefit from any home residual assets. On the contrary, better prospects for the foreign unit (i.e., higher p_f) makes it more likely that the home regulator can reduce its costs for any decision taken. However, as explained above the expected value of residual assets from the subsidiary is larger upon intervention, thus better prospects in the subsidiary make the home regulator tougher on the local unit.

Proposition 1 *With subsidiary representation, (i) regulator h is tougher when $d^f = O$ than when $d^f = I$. For $p_h = p_f$, either prudential regulation coincides in the two countries, or the*

[11] In analogy with our equity stake effect, in a context of sequential investments by a standard domestic bank, Mailath and Mester (1994) show that a regulator may want to intervene in a safe bank, while leaving open a risky one, since this policy allows the regulator to reduce the reimbursement costs of the bank's early-stage investments with the returns of its subsequent investments.

home regulator is tougher than the foreign regulator. (ii) An increase of p_f softens the foreign regulator but toughens the home regulator; an increase of p_h softens the home regulator and leaves the foreign regulator unaffected.

It is interesting to notice that the potential equity returns the home regulator can expect from abroad also increase with a larger R. As the ex-ante value of those returns is higher when there is intervention in the home unit than without intervention, a higher R makes the home regulator tougher (i.e., in figure 1 the boundary δ_h for non-intervention tilts to the right). Although for a different reason, clearly a larger liquidation value L has a similar effect upon decisions of both regulators, making intervention more attractive.

Joint resources of a successful foreign project and of a home project subject to intervention may be sufficient to reimburse all depositors, i.e., $R + L \geq 2$. A novelty in this case is that, since the home regulator benefits from the foreign residual assets up to the point that it makes up for home losses, the regulator can obtain $1 - L$ upon intervention, while recouping $R - 1$ from the foreign unit upon failure of the home unit, with $R - 1 \geq 1 - L$. Hence, *ex-post* (i.e., at $t = 2$) the share of foreign unit's residual assets is now lower with intervention than without it. However, from an *ex-ante* point of view, whether foreign assets are worth more upon intervention (i.e., $p_f(1 - L)$) or failure of the home unit (i.e., $p_f(1 - p_h)(R - 1)$) also depends on p_h. In particular, if $p_h < (L + R - 2)/(R - 1)$ the equity stake effect induces the regulator to be softer and its impact is decreasing in p_h. Now, recall that the decision on the home unit can differ with the status of foreign unit (open or subject to intervention) only because of the equity stake effect; furthermore, with foreign intervention, the regulator leaves the home unit open if $p_h \geq L$ Since $(L + R - 2)/(R - 1) < L$, for the equity stake effect to make the regulator softer, p_h must be so low that in any case the regulator would prefer to intervene in the home unit (because $p_h \ll L$). Hence, notwithstanding the presence of countervailing effects, the home regulator is always tougher when the foreign unit is kept open than when it is subject to intervention (and in the case of a domestic bank with no foreign subsidiary).[12]

It is interesting to note that with $R + L \geq 2$, a higher R increases the foreign unit's residual assets that the regulator can access upon failure, but has no impact on the home regulator's payoff of intervention, it thus makes the home regulator softer. This is in contrast with case of $R+L < 2$, where a higher R makes the home regulator unambiguously tougher. A larger L, instead, results in tougher regulation in this case, as well as when $R + L < 2$, since it increases the value of the assets the regulator can receive from the home unit upon intervention. However, this is the result of potentially countervailing effects since in the current case a larger L also reduces the (expected) value of foreign residual assets that can be obtained by the regulator upon intervention in the home unit.

[12] We thank a referee for pointing out some of the possible differences when $R + L - 2$ is negative or positive.

3.2 Branch MNB

In a branch MNB, the only decision maker is the home regulator. Joint liability of units in a branch MNB implies that, unlike in a subsidiary MNB, losses in *any* of the bank's units must be supported by assets available in the other unit. In particular, residual assets from a successful home unit can reduce the regulator's costs to pay out foreign depositors. Intervention in the home unit, instead, leaves no assets to support a branch that is unsuccessful or subject to intervention. This effect is fully internalized by the home regulator who is now responsible for depositors in both countries. Thus, the home regulator's responsibility for the foreign unit's losses reduces the inclination to intervene in the home unit than would be in the case with a domestic bank. Clearly, given the symmetric nature of liability in a branch MNB, this reasoning also applies to the decision concerning the foreign unit. We will refer to this as an *internalization effect*, which stems from the home regulator's responsibility towards all MNB's depositors.[13]

At the same time, joint liability also opens the possibility for the regulator to reduce costs in any unit with residual assets from the other unit. This is the same *equity stake effect* we have illustrated in the analysis of the subsidiary MNB concerning the home regulator.

To see how the internalization and the equity effects interact, assume first that the regulator intervenes in the foreign unit. Foreign assets will then fall short of liabilities. The regulator's decision on the home unit is then only motivated by the internalization effect: the regulator prefers intervention in the home unit if the liquidation value L is larger than the expected return $p_h R$; that is, if $p_h < L/R$. This immediately shows that, conditional on intervention in the foreign unit, the regulator will be more forbearing in the home unit than would be the case with a domestic bank.

The same internalization effect is also at work when no intervention occurs in the foreign unit: the (open) home unit can potentially support a failing foreign unit. The *ex-ante* value of the residual assets in the home unit is $p_h(1 - p_f)(R - 1)$ now. However, in this case, the equity stake effect is at play as well: residual assets in the foreign unit could be potentially used to reduce the shortfall between assets and liabilities in the home unit. Since the *ex-ante* value of those assets are higher with home intervention than without (respectively, $p_f(R - 1) \geq (1 - p_h)p_f(R - 1)$), the equity stake effect results in tougher regulation of the home unit. Which of the two effects dominates depends on the prospect p_f of the foreign unit. In particular, if p_f is low, it is more likely that the home regulator may have to use residual assets from the home unit to support a failing branch than the other way around. Thus, the internalization effect overweighs the equity stake effect, leading to a softer regulation than would be imposed on a domestic bank. On the contrary, when p_f is large, the equity stake effect prevails, making the regulator tougher than would occur with a single unit.

The following table summarizes the payoffs and illustrates the equity stake and internalization effects referred to the decision on the home unit (symmetrically holds for unit f).

[13] With a subsidiary MNB, although the foreign unit is liable for the home unit's losses, the foreign regulator is not responsible for the home unit's costs. Thus, given the seniority of foreign depositors, the foreign regulator does not internalize the impact of decisions on costs associated with the home unit.

Decisions	Home Regulator's Expected Payoff			
	(Cost on unit f)	(Cost on unit h)	(Internalization effect)	(Equity stake effect)
(I,O)	$-(1-p_f)$	$-(1-L)$		$+p_f(R-1)$
(O,O)	$-(1-p_f)$	$-(1-p_h)$	$+p_h(1-p_f)(R-1)$	$+p_f(1-p_h)(R-1)$
(I,I)	$-(1-L)$	$-(1-L)$		
(O,I)	$-(1-L)$	$-(1-p_h)$	$+p_h(R-1)$	

Table 1: Branch MNB, decisions and regulator's payoffs

Note also that, since the internalization effect is present independently of the decision concerning the foreign unit, whilst the equity stake effect (making the regulator tougher on the home unit) is only at work with an open foreign unit, the regulator is clearly tougher on the home unit when the foreign unit is open than when it is subject to intervention. Formally, with an open foreign unit, intervention in unit h is optimal only if $p_h < \varphi$, where $\varphi_h \equiv \frac{L}{R-2(R-1)p_f}$ is such that $\varphi_h \geq L/R$.

Combining these effects, we can draw Figure 2 to describe optimal decisions for any pair of probabilities (p_h, p_f), where it should be noted that along the 45° degree line (i.e., for $p_h = p_f$) either the decisions are the same, or the regulator is indifferent between decisions (I,O) and (O,I).

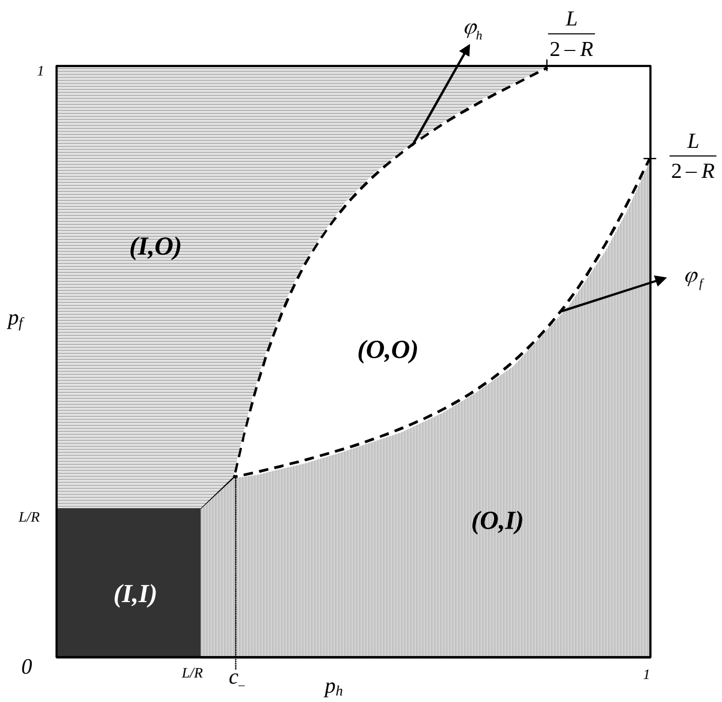

Figure 2: Regulator's decisions (d^h, d^f) with branch-MNB.

Clearly, better prospects for a unit always induce the regulator to be more lenient with that unit, since lower costs are expected from an open decision. Furthermore, a higher probability p_j of success in project j lowers the regulator's expected cost for the other unit i for any decision, because expected residual assets available from unit j increase. However, as explained above, those residual assets have a greater value upon intervention than non-intervention in unit i. Thus, better prospects in unit j induce the regulator to be tougher on unit i.

Proposition 2 *With branch representation, (i) the regulator is tougher on unit i when $d^j = O$ than when $d^j = I$ with $i \neq j$. (ii) An increase of p_i softens the regulator on unit i but toughens her on unit j.*

An increase in the liquidation value L clearly makes the home regulator tougher on any of the units. The effect of a larger R on decisions is more complex: the (I, I) and (O, O) regions shrink whilst (I, O) and (O, I) expand in Figure 2. This is because a larger R makes both the internalization and equity stake effects more pronounced, as it can be seen from Table 1. Hence, which of the two effects prevails with a larger R depends on the probability of success of the projects (p_h, p_f) in the two countries. Consider the decision for the home unit (symmetrically for the foreign unit). Recall that with a low p_f it is more likely that the home unit will need to support a failing foreign unit, rather than the other way around, in which case the internalization effect prevails making the regulator softer on the home unit. On the contrary, when p_f is large, the equity stake effect prevails and makes the regulator tougher. Thus, the effect of a larger R on the regulator's decision for the home unit depends on the prospect of the foreign unit: if it is good, then a larger R tends to make the regulator tougher, if it is bad, it makes the regulator softer. Given that the region with decisions (O, O) is clearly associated with high probabilities of success p_h and p_f, the above reasoning explains why this region shrinks when R increases. Finally, since with intervention in the foreign unit there is no equity stake effect and a larger R increases the internalization effect, this explains why also the region (I, I) shrinks when R increases.

It is interesting to look at the case of $R + L \geq 2$ and examine the effect of an increase of R on decisions. Assume first that intervention occurred in the foreign unit. Given that residual assets in the home unit are useful to the point that the regulator can cover the shortfall between assets and liabilities in the foreign unit (i.e. up to $1 - L$), a higher R will not make the regulator softer on the home unit. If, instead, no intervention occurred in the foreign unit, a larger R will increase the value of residual assets of the home unit for the regulator, making the internalization effect stronger. At the same time, a larger R also increases the ex-post value of foreign residual assets upon home failure, while it has no impact on their value upon home intervention. Thus, a larger R now unambiguously makes the regulator softer on the home unit. This is in contrast with the case of $R + L < 2$ and is the immediate consequence of the different share of equity the regulator can recoup after intervention and failure. A larger L, instead, results in a tougher regulatory behavior towards both units just as in the case of $R + L < 2$, as one would expect.

It is also interesting to note that, when $R + L \geq 2$, the regulator may intervene in at least one unit independently of how large are p_h and p_f, so that decisions (O, O) are never optimal.

Consider the extreme case in which $p_i = 1$ for $i = h, f$. In this case, the regulator is indifferent between decisions (O, O), which clearly lead to nil costs, and decisions (I, O) or (O, I), which also yields to nil cost since, now, joint resources of a successful project and of a project subject to intervention are sufficient to reimburse all depositors. Furthermore, a reduction of either p_h or p_f clearly tend to make decisions (I, O) or (O, I) (strictly) preferred to (O, O). When instead $R + L < 2$, with $p_i = 1$ for $i = h, f$ the regulator *strictly* prefers decisions (O, O) associated with zero costs to decisions (I, O) or (O, I) that lead to the cost $-(1 - L) + (R - 1) < 0$ and this also implies that, for any $p_f < 1$ and $p_h < 1$ sufficiently close to unity, decisions (O, O) are optimal.[14]

3.3 Prudential regulation and foreign representation

Our previous analysis identified the two main drivers for different regulations with branch and subsidiary MNBs, the internalization effect and the equity stake effect. By being responsible for depositors in both countries, the single regulator of a branch MNB fully *internalizes* the effect on a given unit of decision in the other unit. By being responsible only for claims in their own country and acting independently, the two national regulators of a subsidiary MNB, instead, fail to internalize the effect of their decisions on the other country. Concerning the *equity stake* effect in a subsidiary representation, as the home unit is not liable for the subsidiary's losses, the foreign regulator cannot count on (residual) assets of the home unit. On the contrary, in a branch representation, any of the units can draw upon the residual assets of the other unit.

For a convenient decomposition of the actual decisions into these two effects, we consider a fictitious representation with two national regulators, but with the symmetric liability structure of a branch MNB. This hybrid representation differs from a subsidiary MNB in that the foreign regulator too can draw on residual home assets when foreign assets fall short of liabilities. By comparing decisions in a subsidiary MNB with those in the hybrid representation, we can isolate the role of the equity stake effect, which is relevant for the foreign regulator of the hybrid representation but not for that of a subsidiary MNB. It is easy to see that in the hybrid representation the foreign regulator is tougher on the foreign unit than would occur in a subsidiary MNB. As explained above, the regulator's equity stake in a given unit's assets has greater value with intervention in the other unit than without. For the same reason, the foreign regulator is tougher when using home assets to safeguard foreign depositors. In response to tougher regulation on the foreign unit, the home regulator of the hybrid representation is then softer on the home unit than would be possible in a subsidiary MNB.

Next we compare decisions in the hybrid representation with those of a branch MNB. Any difference that emerges can only be attributed to the internalization effect, which plays a role with

[14] A *joint* reduction to $p_f = p_h = 1 - \Delta$ for same $\Delta > 0$ has three effects on the costs of decisions (O, O): (i) the deposit-reimbursement cost specific to unit h increases by Δ, as well as that of unit f; (ii) the value of home assets to support a failing unit f increases from zero to $p_i(1 - p_j)(R - 1) = \Delta(1 - \Delta)(R - 1)$ (internalization effect); and (iii) the value of foreign assets to support a failing unit h also increases to $p_f(1 - p_h)(R - 1) = \Delta(1 - \Delta)(R - 1)$ (equity stake effect). At the same time, the cost of decisions (I, O) increases by $\Delta(2 - L)$ (payoff with decisions (I, O) is $-(1 - p_f)(2 - L)$ when $R + L \geq 2$). Hence, decisions (O, O) are dominated by (I, O) if $L \geq 2(1 - \Delta)(R - 1)$, which is satisfied for any (small) $\Delta > 0$ when $L \geq 2(R - 1)$.

branch but not with hybrid representation. The single regulator of a branch MNB internalizes all the potential benefits of keeping unit i open in terms of the residual assets that this unit may provide to reduce costs in unit j. Hence, the regulator's responsibility for all deposit insurance in a branch MNB induces greater leniency than would be possible for the two regulators of the hybrid representation.

By putting together the equity stake and the internalization effects, we finally obtain the overall comparison between decisions in a subsidiary and a branch MNB.

Proposition 3 *The home unit is subject to softer regulation with branch than with subsidiary representation. The foreign unit is subject to softer regulation with branch than with subsidiary if* $p_h \leq \max\{L, 1/2\}$ *, and to stricter regulation otherwise.*

Consider first the decision on the home unit. By adding together the equity stake and the internalization effects discussed above, one immediately sees that regulation for the home unit is softer in a branch than in a subsidiary MNB: both the effects point in this direction.

Things are more complicated with the foreign unit. On the one hand, because of the equity stake effect a branch faces tougher regulation than does a subsidiary. On the other hand, for the internalization effect a single regulator tends to be softer on any of the units, i.e., also on the foreign unit. Hence, the internalization and equity stake effects have opposite impacts. Interestingly, Proposition 3 shows that the probability of success of the home unit discriminates between these two countervailing forces. When p_h is low, intervention in the home unit takes place, and the internalization effect makes regulation more lenient under branch representation (no internalization effect in this case). When p_h increases, the internalization effect is reduced (home unit is likely to be open) and at the same time the equity stake effect becomes stronger, resulting in tougher regulation in a branch than in a subsidiary.

The same considerations also apply to the decision for both units when $R + L \geq 2$.

4 The choice of foreign representation

Several factors may play a role in a bank's decision to expand abroad and in its choice of foreign representation, so that some questions naturally arise: Is foreign expansion profitable for a domestic bank? What is the most preferred foreign representation if the bank decides to expand abroad? What are the consequences of foreign expansion for regulators?

To answer these questions, we analyze a purely domestic bank, which at time $t = 0$ has the possibility to expand abroad and has to decide on the form of foreign representation. At $t = 0$ the bank knows the home unit's prospect p_h, but is uncertain about the foreign unit's prospects which distribute according to a random variable $\widetilde{p}_f$ with uniform c.d.f. $F(p_f)$ over the support $[0, 1]$.[15] The continuation of the game after $t = 0$ is as outlined in the previous sections.

We first analyze the case in which regulators do not impose any restriction over the foreign representation, so that the bank is free to choose whether to expand at all and, if it does, whether

[15] We will also discuss to what extent our results are more general or depend on the assumption for the distribution.

to do so *via* branch or subsidiary (Section 4.1). Anticipating regulators' prudential regulation at $t = 1$ for any representation form, the bank then takes the $t = 0$ decision that guarantees the maximum expected profit. We indicate with D, B, and S the bank's $t = 0$ decisions, respectively for remaining a domestic bank, and expanding abroad with a branch, or with a subsidiary. We then analyze regulators' preferences on whether the bank should expand abroad and with what representation form (Section 4.2).

4.1 Bank's choice over foreign expansion and representation

Consider first the case when the bank expands abroad *via* subsidiary. Recall that, with subsidiary MNB, if the home unit is subject to intervention, profits are nil, so that the bank generates zero profits if $p_h < L$. If instead $p_h \geq L$, profits are

$$\Pi_S = \begin{cases} p_h(R-1)\int_0^L dF(p_f) & \text{if } L \leq p_h < c_-^S \\ p_h(R-1)\{\int_0^L dF(p_f) + \int_L^{\hat{\delta}_h}(1+p_f)dF(p_f)\} & \text{if } p_h \geq c_-^S \end{cases}$$

The first line corresponds to values of p_h such that the home unit is only open if the foreign unit is subject to intervention, which requires that p_f belongs to the interval $[0, L]$ and c_-^S is the value of p_h such that the boundary δ_h' (which is the inverse function of δ_h) intersects L, see Figure 1.[16] The second line corresponds to values of p_h such that the home unit is open unless the foreign unit is expected to be successful with a high probability, i.e., for any value of $p_f \leq \hat{\delta}_h$, where $\hat{\delta}_h \equiv \min\{\delta_h', 1\}$. In fact, for any $p_f \in [0, L)$, the $t = 1$ decisions will be (O, I) and only the home unit is expected to bring profits. If, instead, $p_f \in [L, \delta_h']$, decisions will be (O, O), and both units are expected to yield positive profit. Finally, for $p_f \in (\delta_h', 1]$, decisions will be (I, O), and the MNB cannot expect any profit, as intervention will occur in the home unit.

Consider now a branch MNB, in which case profits are nil if one of the two units is subject to intervention. Hence, the MNB generates no profits if $p_h < c_-$, where c_- is the value of p_h at which the two boundaries φ_h and φ_f intersect in Figure 2.[17] When instead $p_h \geq c_-$, the expected profit is equal to:

$$\Pi_B = p_h 2(R-1)\int_{\varphi_f}^{\hat{\varphi}_h} p_f dF(p_f)$$

where $\hat{\varphi}_h \equiv \min\{\varphi_h', 1\}$, and φ_h' is the inverse of φ_h. The expression for Π_B shows that a branch MNB only generates profit if both units are open and successful, but in this event the profit is twice as large as that of a domestic bank.

[16] Clearly, δ_h' is a function of p_h and not of the integrating variable p_f. The expression of c_-^S is in the Proof of Proposition 1.

[17] The expression of c_- is in the Proof of Proposition 2.

Finally, a domestic bank is subject to intervention if and only if $p_h < L$, and it thus generates expected profits $\Pi_D = p_h(R-1)$ only if $p_h \geq L$.

As the bank is uncertain about the foreign unit's prospects, but is informed about the home unit, we can characterize its decision based on the home unit's prospect p_h. It follows immediately that, if p_h is sufficiently low, intervention takes place in any case and the bank is indifferent between the three possibilities. On the contrary, for a high p_h (i.e., $p_h > \max\{L, 1/2\}$), Proposition 3 shows that the branch is subject to stricter regulation than is the subsidiary. As a branch MNB does not generate profits unless *both* units are open, for a high p_h expanding abroad with a subsidiary MNB is certainly better than branch representation. Furthermore, for a sufficiently high p_h (i.e., $\frac{L}{(2-R)} \leq p_h \leq 1$) a subsidiary MNB is also better than remaining a domestic bank, since the former provides returns from two projects. For intermediate values of p_h, the preferred decision for the bank is more complex and may depend on the distribution for $\widetilde{p}_f$, as illustrated in the following Proposition.

Proposition 4 *For uniformly distributed priors, if* $p_h \geq \hat{p}_h$ *(with* $\hat{p}_h \in (\max\{c_-, L\}, \frac{L}{(2-R)}]$*), the bank expands abroad with a subsidiary; If* $\max\{c_-, L\} \leq p_h < \hat{p}_h$*, it prefers to remain domestic; If* $c_- \leq p_h < L$*, it prefers to expand abroad with a branch; Finally, if* $p_h < \min\{c_-, L\}$*, the bank is indifferent, since it obtains no profit in any case.*

For intermediate values of p_h we can have two cases. If $c_- \geq L$ (which is equivalent to $L > 1/2$) for any p_h such that $L \leq p_h < c_-$, the bank yields zero profit if it expands abroad with a branch, since intervention occurs in one of the two units. Instead, it obtains a positive (expected) profit by remaining a domestic bank that is also larger than the profit with a subsidiary. This is because, for any p_h in the interval $[L, c_-)$, expected profits are zero with a subsidiary (regulatory decisions are in fact (I, O)), but strictly positive with a domestic bank. This result is driven by the equity stake effect that is at play both for the subsidiary and the branch representation, leading to tougher regulatory decisions in a multinational bank than in a domestic one.

When instead $L \leq 1/2$, for any p_h such that $c_- \leq p_h < L$, the bank generates no profits if it remains domestic or goes abroad with a subsidiary. In a branch MNB, with strictly positive probability, regulatory decisions are (O, O), thus yielding positive expected profit (this is the case for values of p_f such that $\varphi_f \leq p_f \leq \varphi'_h$, and decisions are (O, O), as it can be seen in Figure 2). This is now the consequence of the internalization effect, which is only at play with a branch representation and makes the regulator softer. Note that expanding abroad with a subsidiary MNB is also dominated by remaining a domestic bank due to the equity stake effect.

For $\max\{c_-, L\} \leq p_h$ neither the home unit of a branch MNB nor a domestic bank face intervention. Although a branch MNB can potentially deliver twice as much profit as a domestic bank, it only yields profits if both units are open. Thus, the choice between the two representations now depends on how $\widetilde{p}_f$ is distributed. For low values of p_f intervention in the foreign unit eliminates the possibility for an MNB to earn positive profit; for high values of p_f the foreign unit is kept open, and yields additional profit to the home unit. Hence, a distribution of $\widetilde{p}_f$ sufficiently skewed towards high values implies that a branch MNB is preferred to remaining domestic. When instead any $\widetilde{p}_f$ is equiprobable, the bank prefers to remain domestic rather than to expand abroad with a branch MNB, as shown in the Appendix.

As for the comparison with a subsidiary MNB, the home unit of the subsidiary MNB is always subject to intervention for $\max\{c_{-}, L\} \leq p_h < c_{-}^{S}$, thus it is clearly dominated by a domestic bank. For $c_{-}^{S} \leq p_h < L/(2-R)$, the home unit of a subsidiary is open unless the foreign unit is expected to be successful with a high probability. Furthermore, the higher p_h the higher p_f should be to trigger intervention in the home unit. Thus, the comparison between a domestic bank and a subsidiary boils down on how high p_h is, and how the priors on p_f are distributed. For example, a distribution, that puts weight on intermediate values of p_f, could make the subsidiary representation preferred in the whole interval. With uniform distribution, we show that the threshold p_h that makes subsidiary preferred to remaining domestic lies in the interval $c_{-}^{S} \leq p_h < L/(2-R)$. If instead $p_h \geq L/(2-R)$, the subsidiary is optimal independently of the distribution of $\widetilde{p}_f$, as explained above.

These results hold qualitatively also when $R + L \geq 2$, with a single difference. Since in this case the MNB can still generate profits even if there is intervention in one unit, for sufficiently low values of p_h expanding abroad with a branch MNB is always better than remaining domestic (which in turn yields zero profits for p_h low). Hence, we can identify three relevant regions for the bank's representation choice: for low values of p_h, a branch MNB is preferred to remaining a domestic bank; for intermediate value of p_h, the domestic bank is optimal; for large values of p_h, the bank prefers foreign expansion with a subsidiary.[18]

4.2 Regulators' preferences over foreign expansion and representation

Banks are not always free to choose the preferred representation for foreign units. The empirical literature also emphasizes the importance of constraints imposed by regulation for this choice (see Ursacki and Vertinsky, 1992; Blandon, 1999; Houpt, 1999). Indeed, in some cases, host regulators restrict this choice by imposing a specific representation(s) on foreign banks. Similarly, within the EU, for example, a home regulator can refuse to give license to the bank that wishes to expand abroad *via* branch. We now focus on the representation choice from the regulators' point of view by addressing the question of what mode of entry the foreign regulator would prefer for the multinational bank, if any. Then we also ask the question of what would be the home regulator's preferred choice concerning foreign expansions and representation. In both cases, we will also consider the possibility that the bank remains domestic.

To make the analysis symmetric for the home and foreign regulators, we will assume that each national regulator knows the prospects of the local unit whilst being uncertain about the prospects of the other unit $\widetilde{p}_j$, thereby putting equal weight of any values of $\widetilde{p}_j \in [0, 1]$ (i.e., $F(p_i)$ is uniform as in the previous Section). For the same reason, we also posit that a domestic bank with a single unit exists in the foreign country and the foreign regulator has to decide whether to allow it to be acquired by a bank from another country, thus becoming either a branch or a subsidiary of an MNB.

[18] The exact values of the boundaries for these regions are determined in the Supplementary Material.

Since we aim to analyze regulators' preferences over representation, we will not explicitly consider the representation choice as a game between regulators. Consistently, we also assume that regulators cannot share their information.

The foreign regulator's choice is immediate, always preferring branch representation to subsidiary (or to blocking the acquisition of the domestic bank), since a branch MNB lifts the foreign regulator's responsibility towards local depositors.

Comparing a subsidiary MNB with a domestic bank, the home regulator clearly prefers the former to the latter. Indeed, for the home regulator, the presence of the foreign unit is simply a source of additional resources that could be used to reduce deposit insurance payout costs at home but without bringing additional costs. In particular, when the decision for the home unit is the same in a domestic bank and in a subsidiary MNB, the claim is immediate: (expected) costs for the domestic unit are the same in the two cases, and the foreign subsidiary could bring residual assets $(R-1)$ if it is kept open and succeeds. Nevertheless, decisions for the home unit can be different in the two cases. In particular, for $L \leq p_h \leq \delta_h$, the home unit is subject to intervention in a subsidiary MNB when p_f is sufficiently high (i.e., $p_f \geq L$), whilst it is kept open in a domestic bank. However, in this case the home regulator's cost in a subsidiary MNB must be smaller with intervention than with an open decision, otherwise the regulator would have preferred the latter decision. Hence, the home regulator's preference for subsidiary MNB follows.

The comparison between subsidiary and branch for the home regulator is more complex. If decisions at $t = 1$ were identical for the MNB's two units under the different representations, a subsidiary MNB would always dominate a branch MNB. Indeed, while a branch brings both potential costs and potential residual assets to the home regulator, for the same decisions the subsidiary brings the same (expected) residual assets but no additional costs.

However, regulatory decisions might differ in the two representations in a way that makes the comparison potentially ambiguous for the home regulator. In particular, for $p_h \leq \max\{L, 1/2\}$ in a subsidiary MNB, the home regulator might not expect additional assets from abroad because of intervention in the foreign unit, while an open branch could bring larger expected benefits than costs to the home regulator. This could be the case, for example, when $p_h < L/R$ and $p_f \in [L/R, L]$, in which case the home unit faces intervention under both representations while the foreign unit is subject to intervention if it is a subsidiary but not if it is a branch. Consequently, a distribution for $\widetilde{p}_f$ that puts sufficient weight to these intermediate values of p_f could make a branch MNB preferred over a subsidiary MNB. However, as shown in the Appendix, if any p_f is *a priori* equiprobable, then it results in the subsidiary dominating the branch MNB.[19]

Proposition 5 *For uniformly distributed priors, the foreign regulator always prefers a branch MNB. The home regulator prefers the bank to expand abroad with a subsidiary MNB.*

It is also interesting to note that, for the home regulator, the comparison between giving a domestic bank the license to go abroad *via* branch and restricting it to remain domestic could

[19] As shown n the Appendix the dominance of the subsidiary over the branch representation also carries through when, although decisions are *different* for the *foreign* unit, a subsidiary faces softer regulation than a branch.

also depend on the distribution for p_f (whilst the domestic bank is certainly dominated by the subsidiary, as previously discussed). The reason is similar to what discussed in the bank's representation choice of Section 4.1. In fact, with branch representation, the payoff of the home regulator is increasing in p_f for any pair of decisions. When p_f is sufficiently low, the decision on the foreign unit is intervention, and in this case the payoff with branch representation is always lower than when the bank remains domestic. When instead p_f is sufficiently high, the decision on the foreign unit is to keep it open, and the foreign unit tends to bring more benefits than costs. However, as shown in the Appendix, when any $\widetilde{p}_f$ is equiprobable, the home regulator prefers the bank to remain domestic rather than to expand abroad with a branch MNB, which is then the worst possible option.

The reasoning that led to our previous discussions and the results in Proposition 5 qualitatively apply also for the case of $R+L \geq 2$. The only interesting feature is that, since the decision to keep both units open in a branch MNB may be less likely to happen (as discussed in Section 3), a branch MNB becomes even less desirable to the home regulator than when $R+L < 2$.

5 Welfare-maximizing regulators

Regulators can also be concerned by the MNB's profits in addition to the costs of deposit insurance. For example, their mandate may explicitly embrace banking profitability, as the financial stability of the local banking industry could be jeopardized by a drastic reduction in banks' profits. Alternatively, lobbying could induce the regulator to be concerned with profits. We now extend our previous analysis with the possibility that, in addition to the deposit insurance costs, a regulator also takes into consideration the profits generated by the MNB's unit(s) within that regulator's jurisdiction.

Joint liability of an MNB's units implies that local profits might be shifted to support a failing unit in another country. For a regulator in charge of both units and maximizing the sum of expected deposit insurance costs and profits in the two countries, it does not matter whether local profits remain in the country or are channelled to another country to reduce the shortfall between assets and liabilities. On the contrary, for national regulators in charge of a single unit of a MNB, local profits might count only to the extent to which they remain in the country (e.g., they are reinvested or redistributed locally). In accordance with this view, we make the assumption that the regulator in charge of a given unit takes into account that unit's profits only when they are not channelled to the other country.

A subsidiary representation introduces a new feature of the analysis: when the foreign regulator is interested in profits, the decision is affected by the status of the home unit. Recall that the MNB makes no profit if one regulator intervenes. Hence, no intervention at home now induces the foreign regulator to be softer than when the home unit is subject to intervention. Furthermore, as with an open home unit, a higher p_h increases the probability that the foreign regulator can actually benefit from foreign profits, and this makes the foreign regulator softer towards the foreign unit.

When the foreign unit is open, the home regulator's decision becomes shaped by two forces. As with cost-minimization, the home regulator's claim to the residual resources of the foreign unit has a higher value with intervention than without. With home intervention, on the other hand, an MNB's profits are nil at home and abroad. With costs counting no less than profits, the first effect has a greater impact on the decision, so the home regulator is tougher when the foreign regulator is softer, exactly as in the case of cost-minimization.

An interesting consequence of regulators caring for profits is the emergence of mixed strategies. Assume, for example, that the home regulator decides to intervene. As discussed above, this might prompt the foreign regulator to intervene, which, in turn, might make the home regulator change the decision to non-intervention. This cyclical pattern of decisions shows that a pure strategy equilibrium could fail to exist. The presence of mixed-strategy equilibria is interesting and realistic, since in some circumstances a regulator might want to intervene with positive probability but not with certainty. In the bank regulation literature, Freixas (1999) suggests that, to improve bankers' ex-ante incentives, the lender of last resort might employ mixed strategies to create "constructive ambiguity" with respect to the bail-out decision. Interestingly, the kind of ambiguity that emerges in our analysis for the regulator's decision is novel and clearly independent of this motivation, since it is a consequence of strategic interaction between two independent national regulators.

Consider, now, branch representation. Consistent with what stated above, the home regulator of a branch MNB cares about the profits of all units and thus maximizes the sum of expected deposit insurance costs and bank profits in the two countries. Hence, from the regulator's point of view, it does not matter whether a local unit's profit remains in a country, or if it is used to reduce deposit insurance costs in another country. As returns from investment in the two units are independent, the optimal intervention rule in country i does not depend on the decision in country j. For a probability of success p_i, no intervention in unit i yields expected welfare $-(1-p_i)+p_i(R-1)$, and intervention results in $-(1-L)$. Thus, when the expected returns p_iR are larger than the liquidation value L, or $p_i \geq L/R$, the optimal course of action for the home regulator is no intervention. This shows that profit concerns make the regulator to be softer than when cost is the only concern.

Proposition 6 *When regulators also value profits, (i) they are softer than when they are only concerned by costs; and (ii) all units of a subsidiary MNB now face tougher regulation than those of a branch MNB.*

Concerning point (ii) in the Proposition, it is easy to see why a subsidiary faces a tougher regulation than does a branch. The foreign regulator only cares about costs associated with the local unit, since there is no responsibility for depositors in the home country. Thus, the foreign regulator is not indifferent between the local profit remaining in the country or being channelled to the home regulator to reduce the deposit insurance payout. Only benefitting from the subsidiary profit with a solvent home unit, the foreign regulator values profits less than would a regulator of a branch MNB. In fact, in case the home unit is subject to intervention, there are no profits left for the foreign regulator, whilst the home regulator of a branch MNB benefits from the residual assets of the foreign unit. If the home unit is kept open, the foreign regulator can count on the potential profits of the subsidiary only if the home unit succeeds, i.e., with probability p_h; whilst the home regulator of a branch MNB values those profits (if they are realized) independently of the prospects p_h of the home unit.

Concerning the decisions over the home unit under the two representation forms, in the case of a branch MNB, as argued earlier, the decision over a given unit is independent of the decision over the other unit. With a subsidiary MNB, instead, the equity stake effect makes the home regulator's decision dependent on the foreign regulator's decision and leads to a tougher decision if the foreign unit is open (otherwise, decisions clearly coincide).[20]

The decision rule for the regulator of a branch MNB is clearly the same, even when $R+L \geq 2$: the home regulator intervenes in unit i if and only if $p_i < L/R$. The interaction between the two regulators of the subsidiary MNB instead exhibits an interesting and new feature since the home regulator could respond to softer foreign regulation by also being softer at home. As explained after Proposition 1, when $R+L \geq 2$ the equity stake effect makes the home regulator softer if $p_h < (R+L-2)/(R-1)$, and its impact is decreasing in p_h. Recall that, absent the equity stake effect, the regulator prefers to intervene in the home unit if $p_h < L/R$, where L/R can now be lower than $(R+L-2)/(R-1)$ (which is precisely the case if $L > (2-R)R$). Thus, there exist intermediate values of p_h such that the equity stake effect is strong enough (since p_h is not too low) to make the regulator indeed softer when the subsidiary is kept open than when it is subject to intervention (or when the subsidiary does not exist, as in the case of a domestic bank).

5.1 Preferences over foreign expansion and representation

Adopting the corresponding assumptions of Sections 4.1 and 4.2, we first illustrate the bank's preferences and then turn to regulators' preferred choices over foreign expansion.

Proposition 6 shows that either regulatory decisions coincide for any unit under the two representations, or a branch MNB faces a softer regulation than does a subsidiary MNB. This implies that the bank prefers the branch representation to the subsidiary form for values of p_h such that intervention in the home unit occurs under subsidiary but not under branch representation. Clearly, for this to be the case, p_h cannot be very small, since intervention in the home unit would then take place under all representation forms; neither can it be very large, since then the home unit would be open under any representation, and in this case, subsidiary would be preferred to the branch representation. This is because home profit in a subsidiary MNB is protected by limited liability of the home unit over the subsidiary's potential losses.

By the same token, it is easy to see that the bank prefers to expand abroad with a subsidiary rather to remain domestic for p_h sufficiently high so that the home unit does not face intervention under subsidiary representation.

Comparing the expected profit of a domestic bank with that of expanding abroad through a branch unit, recall that regulatory decisions for the home unit at $t = 1$ coincide for the two

[20] In the Appendix, we show that the mixed-strategy equilibrium with a subsidiary MNB exists for values of p_h and p_f that correspond to decisions (I, I) with branch representation, hence the clear-cut result in the Proposition.

forms: intervention occurs if $p_h \leq L/R$. Furthermore, the branch MNB only realizes profit if no intervention occurs in any of the units, but in that event it earns twice as much profit as does a single-unit domestic bank. Since intervention in the foreign unit depends on the value of p_f, whilst Π_D is only a function of p_h, it follows that the comparison between Π_D and Π_B is affected by the distribution of p_f. When any possible value of p_f is equiprobable, the larger but uncertain returns of a profitable branch MNB are more than compensated by the smaller profits of a domestic bank that is independent of the realization of a foreign project.[21] Hence, in cases where the bank prefers to expand abroad with a branch rather than with a subsidiary, remaining a domestic bank is even more profitable.

Proposition 7 *For uniformly distributed priors, when regulators maximize welfare, the bank prefers to remain domestic if* $p_h < \overline{p}_h$ *(with* $\overline{p}_h \in [\frac{L}{L+R(1-L)}, L]$*) and to expand abroad with a foreign subsidiary for* $p_h \geq \overline{p}_h$.

Comparing these results with Proposition 4, the main difference is that when regulators are cost minimizers a branch MNB can be the optimal bank's choice for intermediate values of p_h. This stems from the softer regulation a branch MNB could face, compared to a domestic unit, which is a consequence of the regulator taking into consideration the potential profit of the home unit in reducing deposit insurance cost abroad (internalization effect). When regulators maximize welfare, this potential profit enters per-se the regulator's objective function also with a domestic bank, thus eliminating any advantage to the branch MNB.

As we have argued in the previous Section, if $R + L > 2$ regulatory decisions are unaffected in the cases of a branch MNB and of a domestic bank. However, in a subsidiary MNB, the home regulator might respond to softer foreign regulation by also being softer at home. As a consequence, the subsidiary MNB obtains positive profits for a larger set of p_h compared to the case of $R + L < 2$, and these profits are also larger in expected terms. It is then immediate to see that the subsidiary representation is even more attractive for the bank (i.e. the equivalent of $\overline{p}_h$ in Proposition 7 is now even smaller than that in the case of $R + L < 2$).

We now turn to the regulators' preferences on foreign expansion and representation choice. Clearly, the foreign regulator now prefers to keep the domestic bank local instead of facing a subsidiary of an MNB; in the latter case, the foreign unit's profit only remains in the country if the home unit is successful. Although a branch representation reduces the probability of the foreign unit's profit remaining in the country, it also reduces the foreign regulator's cost by transferring the task of insuring foreign depositors to the home regulator. When the prospects of the foreign unit are low, the cost-reducing effect of the branch clearly dominates, since the foreign unit is unlikely to yield any profit. When the prospects of the foreign unit are good, the opposite occurs. This suggests that there exists an intermediate value of p_f below which a branch MNB dominates the domestic bank, while the opposite occurs above this value. The cut-off value naturally depends on the distribution of $\widetilde{p}_h$, and a distribution that is skewed towards high (low)

[21] Clearly, if the distribution is more skewed towards large p_f, then a branch MNB may dominate a domestic bank.

values of $\widetilde{p}_h$ increases (decreases) the threshold level of p_f above which a domestic unit is preferred to a branch MNB.

Regarding the home regulator's preferences, foreign expansion with a subsidiary clearly dominates the alternative of a domestic bank. The intuition is the same as in the case of cost-minimizing regulators in Section 4.2: for the home regulator, the subsidiary is simply a source of additional resources that could be used to reduce deposit payout shortfall at home at no additional cost. On the contrary, the branch yields additional costs to the home regulator, but at the same time it also brings additional profits. Whether the additional cost or profit is stronger in general depends on the prospect of the foreign unit, so that a distribution of $\widetilde{p}_f$ sufficiently skewed towards high values of p_f leads to a branch MNB being preferred to a domestic bank (viceversa for distribution skewed towards low values of p_f). When all values of $\widetilde{p}_f$ are equiprobable, as shown in the Appendix, the home regulator prefers the bank to remain domestic rather than to expand abroad with a branch MNB.

Finally, comparing a branch MNB to a subsidiary MNB, Proposition 6 shows that a branch MNB faces a softer decision than does a subsidiary MNB. This implies that *ceteris paribus* with a branch MNB the home regulator is more likely to benefit from foreign resources. However, the branch brings additional costs to the regulator as well, compared to the subsidiary. Hence, if the home regulator is optimistic about the prospects of the foreign unit, branch representation dominates subsidiary representation; otherwise subsidiary is preferred to branch, as in the case of equiprobable p_f.

Proposition 8 *For uniformly distributed priors, when regulators maximize welfare, the foreign regulator prefers to face a branch MNB if* $p_f \leq \underline{p}_f$ *(with* $\underline{p}_f \geq L/R$*) and a domestic bank otherwise. The home regulator prefers the bank to expand abroad with a subsidiary representation form.*

When $R + L \geq 2$, the analysis of Section 5 shows that the $t = 1$ regulatory decisions with a branch MNB (and obviously also with a domestic bank) are unaffected. On the contrary, a subsidiary MNB obtains positive profits for a larger set of p_h compared to the case $R + L < 2$. Thus, when the home regulator also values profit, a subsidiary MNB becomes even more preferable than a branch MNB, confirming the results in Proposition 8. The foreign regulator's preferences on representation are neither affected by how large $(R + L)$ is with respect to the total liabilities of the MNB. Even if a subsidiary MNB might lead to softer decisions on the home unit, compared to the previous case of $R + L < 2$, foreign profit could still be channelled abroad, which in turn elevates the preference of a domestic bank over a subsidiary of a MNB for the foreign regulator. Furthermore, as regulatory decisions in a branch MNB coincide under the two parametric cases, so too does the ranking between a domestic bank and a branch MNB, as discussed at the end of Section 4.2.

6 Discussion and Concluding Remarks

Our understanding of the complex issues surrounding the regulation of multinational banks is still rudimentary, and the results of this theoretical paper and its stylized model should certainly not be accepted unquestioningly, particularly as regards policy implications. Nevertheless, our simple model does prove sufficiently versatile to deal with several important issues in MNB regulation.

We show that different representation forms can generate different regulatory responses. In this respect, the liability structure of MNB units and the regulator's responsibility for foreign depositors determined by a particular representation form play a crucial role in explaining these differences. With regulators concerned with deposit insurance costs, we find that branch representation leads to softer regulation for the home unit than does subsidiary representation, while the foreign unit can face tougher or softer regulation depending on the prospects of the home unit.

With these indications concerning regulatory attitude towards the two representation forms, we analyze the bank's decision whether to expand abroad and what representation form to choose. We show that a bank prefers to expand abroad *via* subsidiaries when the home investment is sufficiently safe. Instead, a bank may prefer a branch foreign representation if the home investment is unlikely to be successful, so as to tilt the regulator's decision from intervention to an open decision. In intermediate cases, the bank prefers not to expand abroad at all. It is interesting to see how these results fare with empirical evidence. Europe has a "single passport" scheme (EEC, 1989) designed to reduce protective barriers to entry by allowing any EU bank to establish branches elsewhere in the EU. This legislation notwithstanding, many banks have preferred to expand abroad by establishing subsidiaries within the EU (Dermine, 2002). Similarly, subsidiaries of EU and US banks dominate in both Latin America and Eastern Europe, where banks may choose freely between branch and subsidiary. Although our stylized model fails to consider other important factors in banks' choice, it does explain this behavior on the assumption that banks in the EU and the US hold quite a safe portfolio of projects at home and that foreign projects available in Latin America or Eastern Europe are on average riskier. On the other hand, there is evidence that Asian banks prefer branches for expansion outside Asia, a fact that could be consistent with the result in Proposition 4 in case the prospect of the home unit is not very high.[22]

In our base model, we have abstracted from several issues in multinational bank regulation.

In particular, we have not considered the possibility that regulators can improve their knowledge on the bank's prospects by means of monitoring. With a subsidiary MNB, monitoring and prudential supervision are typically unified under the responsibility of national regulators. However, the regulator in charge of prudential supervision of a branch MNB might not be the same individual that can actually monitor the foreign unit, which naturally creates misalignments between regulators, inefficient decisions and potential problems in sharing relevant information.[23]

[22] Japanese banks, for example, seemingly preferred branches in their expansion into the US and the EU. See the BIS Report (2001) on the activities of multinational banks in emerging markets. See also Focarelli and Pozzolo (2006).

[23] See for example Repullo (2001) and Holthausen and Rønde (2002). In the present paper, we abstracted from the information-sharing issue, partly because we think that the blurring of supervisory information is more likely to be a problem between countries at different levels of institutional development. In those countries, however, MNBs are more likely to choose the subsidiary form (to limit the risk exposure of the home unit), which in turn implies less need to rely on foreign supervisory information because the liability structure naturally insulates the home unit

In an ongoing research we consider regulatory monitoring: by incurring a cost, the regulator of a given unit could get a perfect signal about the unit's prospective before making a decision regarding intervention. Within the current model setup, we showed that with a subsidiary the foreign regulator has greater incentive to monitor than does the home regulator, while the incentives to monitor are greater under branch than subsidiary representation. We will further develop these ideas in a companion paper.

We have also abstracted from the possible direct negative spill-over from a troubled unit to one that is sound. One could envisage situations in which intervention by the home institutions of a subsidiary MNB would produce withdrawal of assets from the subsidiary, thereby affecting the latter's chances of survival. If such negative spill-over were incorporated in the model, this would create an additional problem of coordination between regulators.

In the present paper we assumed that the home regulator of a subsidiary MNB makes its intervention decision without consulting the foreign regulator. Similarly, we abstract from any reputational concerns that could restrain regulators (and the bank) from making decisions with severe negative impact on other regulators. However, we believe our assumptions capture the less centralized nature of decision-making between national regulators under subsidiary representation.

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7 Appendix

This Appendix contains the proofs for all Propositions when $R + L < 2$. For reasons of space, the corresponding proofs for case $R + L \geq 2$ are in the Supplementary Material available on the authors' web pages.

Proof of Proposition 1. The proof is in two steps. We first derive the equilibrium of the regulation game. Then we prove points (i) and (ii).

Step 1. The following table is the normal form representation of the game between the two regulators (in each cell, the top payoff relates to the foreign regulator and the bottom to the home regulator).

	$d^f = I$	$d^f = O$
$d^h = I$	$-(1-L)$ $-(1-L)$	$-(1-p_f)$ $-(1-L)+p_f(R-1)$
$d^h = O$	$-(1-L)$ $-(1-p_h)$	$-(1-p_f)$ $-(1-p_h)+(1-p_h)p_f(R-1)$

Table A 1

Let us define $\delta_h \equiv \frac{L}{1-p_f(R-1)}$ (which can also be written in terms of p_h, i.e., $\delta_h' \equiv \frac{p_h-L}{p_h(R-1)}$) so that if $d^f = O$ then the optimal decision for regulator h is $d^h = O$ if $p_h \geq \delta_h$ and $d^h = I$ otherwise. For future reference we also note that the decisions of regulator h can also be described in terms of p_f, so that if $d^f = O$ then the optimal decision is $d^h = O$ if $p_f \leq \delta_h'$, and $d^h = I$ otherwise. For any pair of probabilities $(p_h, p_f) \in [0,1]^2$, the Dominant Strategy equilibrium of this game is unique (both in pure and mixed strategies). In fact, if $p_f \geq L$, then the (dominant) strategy of regulator f is $d^f = O$ and the optimal decision for regulator h is $d^h = O$ if $p_h \geq \delta_h$ and $d^h = I$ if $p_h < \delta_h$. If instead, $p_f < L$ then the (dominant) strategy of regulator f is $d^f = I$, and the optimal decision for regulator h is $d^h = O$ if $p_h \geq L$ and $d^h = I$ if $p_h < L$. Hence, we can summarize the equilibrium decisions in terms of the probabilities $(p_h, p_f) \in [0,1]^2$: the set of probabilities such that the equilibrium is (I, I) can be defined as $(I, I) \equiv \{(p_h, p_f) : p_i < L, i = h, f\}$ and similarly for the following sets: $(O, I) \equiv \{(p_h, p_f) : p_h \geq L > p_f\}$; $(I, O) \equiv \{(p_h, p_f) : \delta_h > p_h, p_f \geq L\}$; $(O, O) \equiv \{(p_h, p_f) : p_h \geq \delta_h,\ p_f \geq L\}$. (Hence, with a slight abuse of notation, in what follows

(d^h, d^f) also denote the set of probabilities such that (d^h, d^f) are the equilibrium decisions.) All these sets (depicted in Figure 1) are non empty. Indeed, boundary δ_h takes value $L/(2-R)$ with $L < L/(2-R) < 1$ for $p_f = 1$, so that regions (I, O) and (O, O) are non empty and regions (I, I) and (O, I) are also trivially non empty. Furthermore, for any of the four regions, the Nash equilibrium is clearly in pure strategies and it is unique.

Step 2. Result (i) simply follows from $\delta_h \geq L$, so that for $\delta_h \geq p_h \geq L$ the optimal decision is $d^h = I$ if $d^f = O$, but $d^h = O$ if $d^f = I$. As long as $p_h = p_f < L$, both regulators prefer to intervene in the local unit. Moreover, boundary δ_h takes value L at $p_f = 0$ (similarly, $\delta'_h = L$ for $p_h = c_-^S$ with $c_-^S \equiv \frac{L}{1-L(R-1)}$), it takes value $L/(2-R)$ with $L \leq L/(2-R) \leq 1$ at $p_f = 1$, and, finally, it is an increasing function of p_f. Hence, δ_h crosses the 45° line once at $p_h = \frac{R-\sqrt{1-4L(R-1)}}{2(R-1)} \geq L$. This suffices to show that when $\frac{R-\sqrt{1-4L(R-1)}}{2(R-1)} > p_h = p_f \geq L$, then the equilibrium decisions are (I, O), and (O, O) if instead $p_h = p_f \geq \frac{R-\sqrt{1-4L(R-1)}}{2(R-1)}$.

As for result (ii), the decisions of regulator f are clearly unaffected by p_h, and an increase of p_f can only indue regulator f to take $d^f = I$ instead of $d^f = O$, but not vice versa. This is also the case for regulator h when $d^f = I$. On the contrary, when $d^f = O$ note that δ_h is an increasing function of p_f, so that a larger p_h can only change $d^h = I$ into $d^h = O$, but a larger p_f can only change $d^h = O$ into $d^h = I$. ■

Proof of Proposition 2.

The proof is in two steps. We first derive the optimal decisions and then prove points (i) and (ii).

Step 1. If $d^i = I$ the MNB will be unable to pay back the depositor at $t = 2$ (because $R + L < 2$). Furthermore, if $d^j = O$ and unit j ends up with a successful project (with probability p_j), the total assets of the bank will be $R + L < 2$, so that the regulator incurs a cost of $-2 + (R + L)$. On the contrary, if unit j ends up in a bad state (with probability $1 - p_j$), the bank's total assets will be L. If, instead, both units are allowed to proceed, the regulator has to reimburse all depositors if both projects turn out to be bad, with an expected cost equal to $-2(1-p_h)(1-p_f)$. Alternatively, one of the two project could turn out to succeed while the other fails (with probability $(1-p_i)p_j$), so that the regulator's cost amounts to $-(2-R)$. Hence, the regulator's payoffs are summarized in the following table.

	$d^f = I$	$d^f = O$
$d^h = I$	$-2(1-L)$	$-(1-L) + p_f(R-1) - (1-p_f)$
$d^h = O$	$-(1-L) + p_h(R-1) - (1-p_h)$	$-[(1-p_h)p_f + (1-p_f)p_h](2-R)+$ $-(1-p_h)(1-p_f)2$

Table A 2

Let us define $\varphi_i \equiv \frac{L}{R-2(R-1)p_j}$ and $\varphi'_i \equiv \frac{Rp_i - L}{2p_i(R-1)}$ for $i = h, f$, so that, if $d^j = O$, then the optimal decision is $d^i = O$ if $p_i \geq \varphi_i$ (equivalently if $p_j \leq \varphi'_i$), and $d^i = I$ otherwise. Moreover, if $d^j = I$ then the optimal decision is $d^i = O$ if $p_i \geq L/R$, and $d^i = I$ otherwise. Now note that, if decisions (O, O) are better than (I, O) and (O, I), then necessarily they are also better than (I, I), since we have $\varphi_i \geq L/R$ for any p_i. Hence, we can define the following sets of probabilities with associated decisions: $(I, I) \equiv \{(p_h, p_f) : p_i < L/R, i = h, f\}$; $(O, I) \equiv \left\{(p_h, p_f) : \varphi_h > p_h, p_f \geq \max\left\{\frac{L}{R}, p_h\right\}\right\}$; $(I, O) \equiv \left\{(p_h, p_f) : \varphi_h > p_h, p_f \geq \max\left\{\frac{L}{R}, p_h\right\}\right\}$; $(O, O) \equiv \{(p_h, p_f) : p_i \geq \varphi_i, i = h, f\}$. The set with decisions (I, I) is non empty, since $L/R \leq 1$. For the other decisions, note that boundaries φ_h' and φ_f are both increasing in p_h and intersect at $p_h = c_\pm \equiv \frac{R \pm \sqrt{R^2 - 8L(R-1)}}{4(R-1)}$ iff the discriminant in $c_\pm$ is positive, i.e., $L \leq \frac{R^2}{8(R-1)}$. This is always the case because $L + R \leq 2$, which also implies that $c_+ > 1$, and then the two curves φ_h' and φ_f intersect only at c_- in the space of probabilities. Furthermore, $\varphi_h' = 1$ for $p_h = \frac{L}{2-R}$, and $\varphi_f = \frac{L}{2-R}$ for $p_h = 1$. Hence, also sets (O, O) or (I, O) or (O, I) are non empty.

Step 2. To prove result (i) in Proposition 2, simply note that for any i we have $\varphi_i \geq L/R$. For result (ii), consider first boundary L/R which discriminates between decisions $d^i = O$ and $d^i = I$ when $d^j = I$. A higher p_i can only induce a decision change from $d^i = I$ to $d^i = O$, if any. On the contrary, φ_i is increasing in p_j, and this implies that with a higher p_j the home regulator needs to face a higher p_i in order to take decision $d^i = O$. Hence, if a larger p_j affects the home regulator's decision at all, it induces a change from $d^i = O$ into $d^i = I$. ∎

Proof of Proposition 3. For the same values of the parameters, we need to compare the decisions that the home and the foreign regulator would make with subsidiary or branch representation. Recall from the proof of Proposition 2 that φ_h' and φ_f are both increasing in p_h and intersect at $p_h = p_f = c_-$ with $c_- \leq L$ iff $L \leq 1/2$. Furthermore, $\varphi_f = L$ for $p_h = 1/2$.

Consider first d^h. For $p_h < L/R$, $d^h = I$ is optimal with both representations. For $L > p_h \geq L/R$, $d^h = I$ is optimal with subsidiary MNB, but $d^h = O$ is optimal with branch MNB iff $p_f \leq \max\{p_h, \varphi_h\}$; For $\frac{L}{2-R} > p_h \geq L$, $d^h = O$ with branch MNB iff $p_f \leq \max\{p_h, \varphi_h\}$, and $d^h = O$ with subsidiary MNB iff $p_f \leq \max\{L, \delta_h\}$. Given that $\varphi_h \leq \delta_h$, and that we are considering $p_h \geq L$, also in this case either the decision coincides in the two representations, or it is $d^h = O$ with branch MNB and $d^h = I$ with subsidiary MNB. Finally, if $1 \geq p_h > \frac{L}{2-R}$, d^h coincides under the two representations.

Consider now d^f. With subsidiary MNB we have $d^f = I$ iff $p_f < L$. On the contrary, with branch MNB we have $d^f = I$ iff $p_f < \min\{\max\{p_h, L/R\}, \varphi_f\}$.

Now, when $p_h \leq L/R$,we have $\max\{p_h, L/R\} = L/R$ and $\min\{L/R, \varphi_f\} = L/R$, so that the decisions is $d^f = I$ iff $p_f < L/R$. Hence, in this case either the decision coincides under the two representation forms, or it is $d^f = O$ with branch, and $d^f = I$ with subsidiary MNB.

If instead $p_h > L/R$, then for $c_- \geq p_h > L/R$ we have $\min\{p_h, \varphi_f\} = p_h$, whilst for $c_- < p_h$ we have $\min\{p_h, \varphi_f\} = \varphi_f$. Then, we need to consider the following cases.

Case 1: $c_- \geq p_h > L/R$. With branch MNB we have $d^f = I$ iff $p_f < p_h$ and need to compare c_- with L, which is the boundary for the decision d^f with a subsidiary MNB. If $L \leq 1/2$, then $c_- \leq L$, so that for $p_f < p_h$, $d^f = I$ with the two representations; for $p_h \leq p_f < L$, $d^f = I$ with subsidiary, and $d^f = O$ with branch; for $p_f \geq L$, $d^f = O$ with the two representations. If instead $L > 1/2$, then $c_- > L$ and we have the following: for $L \geq p_h > L/R : d^f = I$ with the two representations if $p_f \leq p_h$; $d^f = I$ with subsidiary, and $d^f = O$ with branch if $L > p_f > p_h$; $d^f = O$ with the two representations if $p_f \geq L$. When, instead, $c_- \geq p_h > L$ then we have the following: $d^f = I$ with the two representations if $p_f \leq L$; $d^f = O$ with subsidiary, and $d^f = I$ with branch if $p_h > p_f > L$; $d^f = O$ with the two representations if $p_f \geq p_h$.

Case 2: $\frac{L}{2-R} \geq p_h > c_-$. With branch MNB $d^f = I$ iff $p_f < \varphi_f$. Again consider first $L \leq 1/2$, implying $c_- \leq L$. For $p_f < \varphi_f$ decision is $d^f = I$ with the two representations; For $\varphi_f \leq p_f < L$ it is $d^f = I$ with subsidiary and $d^f = O$ with branch; For $p_f \geq L$ it is $d^f = O$ with the two representations. When instead $L > 1/2$, so that $c_- > L$, then, either d^f coincides under the two representations, or we have $d^f = O$ with subsidiary, and $d^f = I$ with branch if $p_f < \varphi_f$.

Case 3: $1 \geq p_h \geq \frac{L}{2-R}$. Again either d^f coincides under the two representations, or we have $d^f = O$ with subsidiary, and $d^f = I$ with branch if $p_f < \varphi_f$.

Summarizing all these cases for d^f we have the following. Let first be $L \leq 1/2$. If $p_h > 1/2$, then either d^f coincides under the two representations, or it is $d^f = O$ with subsidiary and $d^f = I$ with branch. If, instead, $p_h \leq 1/2$, then either d^f coincides, or it is $d^f = O$ with branch and $d^f = I$ with subsidiary. Consider now $L > 1/2$. If $p_h > L$, then either d^f coincides with the two representations, or it is $d^f = O$ with subsidiary and $d^f = I$ with branch. If, instead, $p_h \leq L$, then either d^f coincides, or it is $d^f = O$ with branch and $d^f = I$ with subsidiary. This finally proves that the foreign unit is subject to softer regulation with branch than with subsidiary if and only if $p_h \leq \max\{L, 1/2\}$. ■

Proof of Proposition 4. Note that $L/(2-R) \geq c_-^S \geq \max\{L, c_-\}$ and also that $L \geq c_-$ if and only if $L \leq 1/2$. Hence, there are five possible cases to analyze.

Case 1: $p_h < \min\{c_-, L\}$. We trivially have $\Pi_i = 0$, $i = D, B, S$.

Case 2: $\min\{c_-, L\} \leq p_h < \max\{c_-, L\}$. Consider first $L \leq 1/2$, so that $L \geq c_-$. We immediately have $\Pi_S = 0$, $\Pi_B > 0$, and, for $p_h < L$, the bank is strictly better off to go abroad since if it remains a domestic bank then the regulator will close it, resulting in a profit $\Pi_D = 0$. If instead, $L > 1/2$ so that $L < c_-$, then for $p_h < c_-$ we have $\Pi_B = 0$; with the subsidiary representation the home unit is open for $L \leq p_h$, so that $\Pi_S = p_h(R-1)\Pr(p_f \leq L)$. However, if it remains a domestic bank, it will be kept open and the expected profit is $\Pi_D = p_h(R-1) > \Pi_S$.

Case 3: $\max\{c_-, L\} \leq p_h < c_-^S$. For $L \leq p_h$, a domestic bank is always kept open, so that $\Pi_D = p_h(R-1)$; whilst $\Pi_S = p_h(R-1)\Pr(p_f \leq L) < \Pi_D$. Hence, the bank will never choose to go abroad with a subsidiary. Thus, the relevant comparison here is between D and B. In the latter case, since $L/(2-R) \geq c_-^S$ implies $\hat{\varphi}_h = \varphi'_h$, it follows that $\Pi_B = p_h(R-1)(\varphi_h'^2 - \varphi_f^2)$, and then $\Pi_B < \Pi_D$, because $\varphi'_h \leq 1$.

Case 4: $c_-^S \leq p_h < L/(2-R)$. As in case 3, we have $\Pi_B < \Pi_D$. Then, since $p_h < L/(2-R)$ implies $\delta'_h < 1$, we have

$$\Pi_S = p_h(R-1)[\int_0^{\hat{\delta}_h} dF(p_f) + \int_L^{\hat{\delta}_h} p_f dF(p_f)] = p_h(R-1)[\delta'_h + \frac{1}{2}\left(\delta_h'^2 - L^2\right)]$$

and $\Pi_S - \Pi_D = p_h(R-1)\frac{1}{2}\left[\delta'_h\left(2+\delta'_h\right) - L^2 - 2\right]$. Now note that $\frac{\partial[\delta'_h(2+\delta'_h)]}{\partial p_h} = -\frac{2L(L-p_h R)}{p_h^3(R-1)^2} \geq 0$ because we are considering $p_h \geq L/R$. Hence, the difference $\Pi_S - \Pi_D$ is increasing in p_h (in the relevant range of p_h) and $\Pi_S = \Pi_D$ has two roots in p_h

$$r_- \equiv \frac{L}{R+\sqrt{3+L^2}(R-1)} \leq \frac{L}{R-\sqrt{3+L^2}(R-1)} \equiv r_+.$$

Furthermore, we have $r_- \leq \frac{L}{R} \leq c_-^S \leq r_+ \leq \frac{L}{2-R}$. In fact, $r_+ \geq c_-^S$ since $\sqrt{3+L^2} \geq 1+L$ for any $L \in [0,1]$. Similarly, $\frac{L}{2-R} \geq r_+$ since $2 \geq \sqrt{3+L^2}$ for any $L \in [0,1]$. Hence, $\Pi_D \geq \Pi_S$ if $c_-^S \leq p_h \leq r_+$, and $\Pi_D < \Pi_S$ if $r_+ < p_h \leq \frac{L}{2-R}$, so that the boundary $\hat{p}_h$ in the text of the proposition is simply $\hat{p}_h = r_+$.

Case 5: $L/(2-R) \leq p_h \leq 1$. As in case 3, we have $\Pi_B < \Pi_D$. Furthermore, since $p_h \geq L/(2-R)$, we have $\hat{\delta}_h = \hat{\varphi}_h = 1$, and then

$$\Pi_S = p_h(R-1)[1+\int_L^1 p_f dF(p_f)] \geq p_h(R-1) = \Pi_D.$$

■

Proof of Proposition 5. To study the home regulator's preferences, we need to consider several cases that contemplate the different regulatory decisions at $t=1$ with S, B and D. We will indicate with W_i the payoff of the home regulator associated with $i = D, B, S$.

Case 1 $p_h \leq L/R$. Since the regulatory decision is to intervene in the domestic bank, we have $W_D = L-1$. Instead, we have $W_S = W_D + \int_L^1 p_f\,(R-1)\,dF(p_f)$ and

$$W_B = W_D - \int_0^{L/R}(1-L)dF(p_f) - \int_{L/R}^1 (1-p_f R)dF(p_f) = W_D - \frac{1}{2R}(2R - L^2 - R^2)$$

so that $W_B < W_D < W_S$, since $R < 2$ and $L < 2-R$.

Case 2 $L/R \leq p_h < \min\{c_-, L\}$. W_S and W_D are as in case 1, so that $W_S > W_D$ and

$$W_B = W_D - \int_0^{p_h}(1-p_h R)dF(p_f) - \int_{p_h}^1 (1-p_f R)dF(p_f) = W_D - 1 + \frac{R}{2}(1+p_h^2)$$

with $R/2(1+p_h^2) - 1 < 0$, since the maximum value p_h can take is lower than L and $R/2(1+L^2) - 1 < 0$, thus implying $W_B < W_D$.

Case 3 $\min\{c_-, L\} \le p_h < \max\{c_-, L\}$. First assume $L \le 1/2$, so that $c_- \le p_h < L$ and W_S and W_D are as in case 1 with $W_S > W_D$. Now, with some simplifications,

$$W_B = W_D - 1 + p_h R \int_0^{\varphi_f} dF(p_f) + \int_{\varphi_f}^{\varphi_h'} [(p_f + p_h)R - L - p_h p_f 2(R-1)]\, dF(p_f) + R \int_{\varphi_h'}^{1} p_f dF(p_f) \tag{1}$$

so that $W_D - W_B = P$ where

$$P \equiv \frac{L^2 R - p_h [2p_h(R-1) - R] \left[4 - 2(3+L)R + (2+p_h)R^2\right]}{4p_h(R-1)[2p_h(R-1) - R]}.$$

Since the denominator is negative, we have that $W_D \ge W_B$ iff the expression in the numerator is negative. To show that this is the case, we note the following: (i) the expression in the numerator is convex w.r.t. p_h in the relevant range of p_h; (ii) the discriminant in the roots of the associated equation in p_h is always negative, so that in the relevant range either $W_D > W_B$ or $W_D < W_B$; (iii) for $p_h = L$, the numerator in $W_D - W_B$ is clearly negative. From (i)-(iii) it follows that in the relevant range we have $P \ge 0$ and then $W_D > W_B$.

Assume now that $L > \frac{1}{2}$, so that $L \le p_h < c_-$. W_B is as in case 2, whilst $W_D = (1-p_h)(-1)$ and $W_S = (1-p_h)\int_0^L (-1) dFf(p_f) + \int_L^1 [p_f (R-1) + (L-1)]\, dF(p_f)$. It is clear that $W_S > W_D$, since $p_f (R-1) + (L-1) \ge -1$. Furthermore, $W_B - W_D = L - p_h - 1 + \frac{R}{2}(1 + p_h^2)$, which is a convex function of p_h with two roots p_h^- and p_h^+ such that $p_h^- \le L \le c_- \le p_h^+$. Hence, in the relevant range for p_h, we have $W_B < W_D$.

Case 4 $\max\{c_-, L\} \le p_h < c_-^S$. $W_S > W_D$, since the two payoffs are as in case 3 with $L > \frac{1}{2}$. We also have that W_B is as in (1), so that $W_D - W_B = P + (p_h - L) \ge 0$ since $P \ge 0$, as explained above.

Case 5 $c_-^S \le p_h < L/(2-R)$. Note that W_B and W_D are as in case 4, whilst

$$W_S = (1-p_h)\int_0^L (-1) dF(p_f) + (1-p_h)\int_L^{\hat{\delta}_h} (-1 + p_f R) dF(p_f) + \int_{\hat{\delta}_h}^1 (p_f(R-1) - (1-L)) dF(p_f).$$

It is immediate that W_S is larger in the current case 5 than in case 4 by the positive term $\int_L^{\hat{\delta}_h} (p_h - L)\ f(p_f) dp_f > 0$. Hence, since in case 4 we had $W_S > W_D$, *a fortiori* this is true in case 5.

Case 6: $L/(2-R) \leq p_h \leq 1$. We have W_D as in case 5 and,

$$W_S = (1-p_h)[-1+\int_L^1 p_f\,(R-1)\,dF(p_f)],$$

$$W_B = \int_0^{\varphi_f}[-(1-L)+p_hR-1]dF(p_f)+\int_{\varphi_f}^1[-2(1-p_hp_f)+R(p_f+p_h-2p_hp_f)]dF(p_f).$$

It is immediate that $W_S > W_D$ and we also have $W_B - W_D = -\frac{L^2+(2-R)[2p_h(R-1)-R]}{2[2p_h(R-1)-R]} < 0$ since in this case $2p_h(R-1) \geq R$. ■

Proof of Proposition 6.

The decisions with branch representations are as described in the text. Concerning subsidiary MNB, regulators' payoffs are:

	$d^f = I$	$d^f = O$
$d^h = I$	$-(1-L)$ $-(1-L)$	$-(1-p_f)$ $-(1-L)+p_f(R-1)$
$d^h = O$	$-(1-L)$ $-(1-p_h)+p_h(R-1)$	$-(1-p_f)+p_fp_h(R-1)$ $-(1-p_h)+p_h(R-1)+(1-p_h)p_f(R-1)$

Table A 3

With $d^h = I$, regulator f selects I iff $p_f \leq L$; with $d^h = O$, regulator f selects I iff $p_f \leq \delta_f \equiv \frac{L}{1+p_h(R-1)}$, where the δ_f is decreasing in p_h and $\delta_f \in [L/R, L]$. With $d^f = I$, regulator h selects I iff $p_h \leq L/R$; with $d^f = O$, regulator h selects I iff $p_h \leq \delta_h \equiv \frac{L}{R-p_f(R-1)}$, where the δ_h is increasing in p_f and $\delta_h \in [L/R, L]$. Hence, equilibrium decisions are (I, I) for $p_h \leq L/R$ and $p_f \leq L$; (I, O) if $p_h \leq \delta_h$ and $p_f > L$; (O, O) if $p_h > \delta_h$ and $p_f > \delta_f$; (O, I) if $p_h > L/R$ and $p_f \leq \delta_f$. Finally, if $p_h \in [L/R, \delta_h]$ and $p_f \in [\delta_f, L]$ the unique equilibrium is in mixed strategies. Note that being $L/R \leq \delta_h$ and $\delta_f \leq L$ the mixed strategy region is (generically) not empty, and when the equilibrium is in pure strategies then it is unique.

As stated in the text, one immediately sees that the regulator of a branch MNB is softer when also concerned about profits. This is also true for the subsidiary representation, with the only potential ambiguous case arising when considering the mixed strategy region. However, since this region belongs to the set of probabilities $p_f < L$ and $p_h < L$, it corresponds to decisions (I, I) when the regulators are only concerned about costs. Hence, result (i) follows.

For results (ii), we now compare decisions with the two representations. First note that for $p_h \in [L/R, \delta_h]$ and $p_f \in [\delta_f, L]$, the decisions are (O, O) with branch representation. Hence, in this region the probability that a subsidiary MNB unit faces tougher decisions is certainly larger than for a branch MNB unit. Moreover, for the pure-strategies regions, decisions either coincide with the two representations or they are different in the following cases: for $p_f \in [L/R, L]$ and $p_h \leq L$ decisions are (I, I) with subsidiary and (I, O) with branch; for $p_f \in [L, 1]$ and $p_h \in$

$[L/R, \delta_h]$ decisions are (I, O) with subsidiary and (O, O) with branch; finally, for $p_f \in [L/R, \delta_f]$ and $p_h \in [L/R, 1]$ decisions are (O, I) with subsidiary and (O, O) with branch. ■

Proof of Proposition 7. First, it is immediate to see that for any $p_h < L/R$ profits are nil with D, B and S. Next we consider $p_h \geq L/R$. Since we have

$$\Pi_B = p_h(R-1)2\int_{L/R}^{1} p_f dF(p_f) = p_h(R-1)(1-\frac{L^2}{R^2}) \leq \Pi_D = p_h(R-1),$$

then we now need to compare the profits with S and D. Let c_+^S be the value of p_h such that $\delta_h' = \delta_f$, where $\delta_h' \equiv \frac{p_h R - L}{p_h(R-1)}$ and $\delta_f \equiv \frac{L}{1+p_h(R-1)}$, as in the proof of Proposition 6). Similarly, let $c_-^S \equiv \frac{L}{L+R(1-L)}$ be the value of p_h such that $\delta_h' = L$, with $c_-^S \geq c_+^S$, since $\delta_f \leq L$ and δ_h' is increasing in p_h. We then have four relevant cases, considering first larger values of p_h.

Case 1 $L < p_h \leq 1$. Subsidiary MNB is preferred to remaining domestic since

$$\Pi_S = p_h(R-1)[1 + \int_{\delta_f}^{1} p_f dF(p_f)] > \Pi_D.$$

Case 2 $c_-^S < p_h \leq L$. The profit of the subsidiary here is $\Pi_S = p_h(R-1)[\int_0^{\delta_f} dF(p_f) + \int_{\delta_f}^{\delta_h'} p_f dF(p_f)]$ where the first integral corresponds to the profit of the home unit and the second of the foreign subsidiary. It follows immediately that for $p_h = L$ we have $\Pi_S > \Pi_D$. Rewriting Π_S, we have $\Pi_S - \Pi_D = p_h(R-1)\left[\delta_h'(2+\delta_h') - \delta_f^2 - 2\right]/2$ and calculating this difference at $p_h = c_-^S$ we have $\Pi_S < \Pi_D$. Now note that the term $\delta_h'(2+\delta_h') - \delta_f^2 - 2$ in $\Pi_S - \Pi_D$ is increasing in p_h, since δ_h' is increasing in p_h and δ_f is decreasing in p_h. Hence, for the intermediate value theorem there exists a $\overline{p}_h \in (c_-^S, L]$ such that $\Pi_S < \Pi_D$ iff $p_h < \overline{p}_h$.

Case 3 $c_+^S < p_h \leq c_-^S$. For any $p_f \geq L$ we have that the subsidiary MNB generates the same profit as in case 2. For any p_f such that $\delta_h' \leq p_f < L$ in the current case 3 we have mixed strategies, whilst in case 2 we have decisions (O, O), so that Π_S in case 2 cannot be smaller than that in case 3. For any p_f such that $\delta_f \leq p_f < \delta_h'$, decisions are (O, O) both in case 3 and 2, implying that profits Π_S are the same. For any p_f such that $p_f < \delta_f$, decisions are (O, I) again with the same profits Π_S in case 3 and 2. Furthermore, note that in case 3 the value of δ_f is higher than that of δ_f in case 2, which implies that the region in which decisions are (O, O) is smaller and that with decisions (O, I) is larger in case 3 than in case 2. Since the profits associated with decisions (O, O) are larger than those with decisions (O, I), it follows that Π_S in case 3 cannot be larger than Π_S in case 2. From case 2 we also know that for any $p_h < \overline{p}_h$ it is true that $\Pi_S < \Pi_D$; it then follows that in case 3 $\Pi_S < \Pi_D$ for any p_h.

Case 4 $L/R < p_h \leq c_+^S$. Here, also, we have mixed strategies. However, with similar reasoning to that of case 3, we can show that $\Pi_S < \Pi_D$. Indeed, the only difference between cases 3 and 4 is that part of the set of p_f such that decisions are (O, O) in case 3, here corresponds either to mixed strategies or to decisions (O, I), thus leading to smaller profits Π_S. ■

Proof of Proposition 8. Let W_i^f be the payoff of the welfare maximizing regulator f with representation $i = B, S$ or with domestic bank $i = D$. We then have,

$$W_D^f = \begin{cases} L-1 & \text{if } p_f < L/R \\ -(1-p_f) + p_f(R-1) & \text{if } p_f \geq L/R \end{cases} ; \; W_B^f = \begin{cases} 0 & \text{if } p_f < L/R \\ p_f(R-1) \int\limits_{L/R}^{1} p_h dF(p_h) & \text{if } p_f \geq L/R \end{cases}$$

which immediately yields $W_B^f > W_D^f$ for $p_f < L/R$. If instead $p_f \geq L/R$, then $W_D^f \geq W_B^f$ iff $p_f \geq \underline{p}_f \equiv \frac{2R^2}{2R^2+(R-1)(R^2+L^2)}$, with $\underline{p}_f \geq L/R$. Furthermore, $W_S^f = W_D^f$,if $p_f < L/R$ in which case B is optimal for regulator f. Alternatively, we need to compare D with S, and the payoff associated with S might be also affected by mixed strategies. However, for any p_h and any realization of the mixed strategy, with S regulator f obtains a payoff in the set $\{L-1, \; -(1-p_f), \; -(1-p_f)+p_f p_h(R-1)\}$. Since any element in this set is smaller than W_D^f when $p_f \geq L/R$, it follows that $W_D^f > W_S^f$.

Let now W_i be regulator h's payoff with $i = B, S, D$.

Case 1 $p_h \leq L/R$. We have $W_D = L - 1$, $W_S = W_D +$ $(R-1)\int_L^1 p_f dF(p_f)$, $W_B = W_D +$ $(L-1)\int_0^{L/R} dF(p_f) + \int_{L/R}^1 (p_f R - 1) dF(p_f)$, which yields $W_S \geq W_D$, $W_B \leq W_S$ and $W_D - W_B = \frac{(2-R)R-L^2}{2R} \geq 0$.

Case 2 $L/R \leq p_h \leq p_h^2$ where p_h^2 is such that for $p_h = p_h^2$, $\delta'_h = \delta_f$. We then have,

$$W_D = p_h R - 1, \quad W_B = \int\limits_0^{L/R} (L - 1 + p_f R - 1) dF(p_f) + \int\limits_{L/R}^{1} [p_h R - 1 + p_f R - 1] dF(p_f),$$

$$W_S = \int\limits_0^{\delta_f} W_S^{OI} dF(p_f) + \int\limits_{\delta_f}^{L} \tilde{W}_S(p_h, p_f) dF(p_f) + \int\limits_L^1 W_S^{IO} dF(p_f),$$

where $W_S^{d_h d_f}$ is the payoff associated with decisions (d_h, d_f) and $\tilde{W}_S(p_h, p_f)$ is the expected payoff associated with mixed strategies, i.e., $\tilde{W}_S(p_h, p_f) \equiv \sigma_h \left[\sigma_f W_S^{OO} + (1-\sigma_f) W_S^{OI}\right] + (1 - \sigma_h) \left[\sigma_f W_S^{IO} + (1-\sigma_f) W_S^{II}\right]$ with $\sigma_i = \Pr(d^i = O)$ indicating the strategy of regulator $i = h, f$. Now note that $W_S^{OI} = p_h R - 1 = W_D$, and also $W_S^{IO} = L - 1 + p_f (R - 1) \geq W_S^{OO} \geq W_D$ if $p_f \in (L, 1]$. Concerning the mixed-strategy region (i.e., for $p_f \in (\delta_f, L]$), since regulator h must be indifferent between $d^h = I$ and $d^h = O$, for any σ_h we have $\tilde{W}_S(p_h, p_f) = \sigma_f W_S^{OO} + (1-\sigma_f) W_S^{OI}$, where $W_S^{OI} = W_D$ and $W_S^{OO} = p_h R - 1 + p_f(1-p_h)(R-1) \geq W_D$. Hence, we have $\tilde{W}_S(p_h, p_f) \geq W_D$,which, together with the previous results, imply $W_S \geq W_D$. Finally, we have $W_D - W_B =$

$\left[2R - 2L^2 + 2Rp_h + R^2\right]/(2R)$ which is increasing in p_h, and the value of p_h such that $W_D = W_B$ is $p_h = (2L^2 - 2R + R^2)/(2LR) \leq L$, implying that $W_D \geq W_B$.

Case 3 $p_h^2 \leq p_h \leq p_h^3$ where p_h^3 s.t. $\delta_h' = L$ for $p_h = p_h^3$. Payoffs W_D and W_B are as in case 2, and $W_S = \int_0^{\delta_f} W_S^{OI} dF(p_f) + \int_{\delta_f}^{\delta_h'} W_S^{OO} dF(p_f) + \int_{\delta_h'}^{L} \tilde{W}_S(p_h, p_f) dF(p_f) + \int_L^1 W_S^{IO} dF(p_f)$ with $W_S \geq W_D$ for the same reasoning in case 2.

Case 4. $p_h^3 \leq p_h \leq L$. Payoffs W_D and W_B are as in case 2, and $W_S = \int_0^{\delta_f} W_S^{OI} dF(p_f) + \int_{\delta_f}^{\delta_h'} W_S^{OO} dF(p_f) + p_h \int_{\delta_h'}^{1} W_S^{IO} dF(p_f) \geq W_D$, for what stated in case 2.

Case 5. $L \leq p_h \leq 1$. Payoffs W_D and W_B are as in case 2, and $W_S = \int_0^{\delta_f} W_S^{OI} dF(p_f) + \int_{\delta_f}^{1} W_S^{OO} dF(p_f)$ which can be rewritten as $W_S = p_h R - 1 + \int_{\delta_f}^{1} p_f(1 - p_h)(R - 1) dp_f$ so that, finally, $W_S \geq W_D$. ■